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Aquarium Culture of the Aeolid Nudibranch *Berghia*, Predator on the Nuisance Anemone *Aiptasia*
Anthony Calfo

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Aquarium Culture of the Aeolid Nudibranch *Berghia*
Predator on the Nuisance Anemone *Aiptasia*

by Anthony Calfo

In this article I hope to refocus attention on the Aeolid nudibranch *Berghia* as a species of interest and value to the aquarium hobby. What little information exists in popular hobby literature on the topic is indeed concise and sufficient for guiding those intent on succeeding with the culture of this organism. Yet, after more than 10 years since its introduction to aquatic science, this utilitarian sea

diminished presence of the animal in the trade to be an issue in need of address. Among the traditionally difficult, if even possible to keep, specialized members of the Aeolid nudibranchs, *Berghia* are not only attractive, easy to keep, and easy to breed... but they also readily consume one of the most bothersome pest organisms in marine aquaria: *Aiptasia* anemones (AKA glass anemones).

History and Overview

The genus *Berghia* is widely distributed circumtropically in warm and temperate waters. The organism that most people recognize and seek for *Aiptasia* control is commonly identified as *Berghia verrucicornis* (A. Costa, 1864). However, there seems to be some debate about the number and name of species cited or held in regard under this guise. Field pictures and observations of several specimens called by this name throughout the Atlantic, Caribbean and Mediterranean reflect not only variable color, but different morphologies including contrasts between shapes of rhinophores and cerata, the presence of tubercules and ridges or not, and some differences seemingly in the structures of their egg ribbons. It would not be surprising if more than one species makes its way into the aquarium trade.

Another widely distributed Pacific *Berghia*, *B. major*, also lives by the same *modus operandi* of preying on *Aiptasia*. The most prevalent stock of *Aiptasia*-eating nudibranchs in the American trade, however, is heralded as having been collected from the Florida Keys (east coast USA).

Berghia will often live closely associated with each other and they share meals quite peacefully.

Adult *Berghia* grow to about 1" (25 mm), with some growing slightly larger. Their backs (dorsa) are covered with handsome, colored, tassels known as cerata. Cerata perform functions of respiration, digestion and defense. Although this nudibranch consumes and utilizes the zooxanthellae of its cnidarian prey, they cannot be sustained adequately by the borrowed symbiosis with good lighting alone and they must be fed *Aiptasia* several times weekly, if not daily (adults can starve to death in mere days without *Berghia*). With adequate supplies of anemones, however, *Berghia* will be self-sustaining; that is to say, they will reproduce and maintain a breeding colony. For their readiness to propagate, inexhaustible demand from ongoing nuisance growths of *Aiptasia* in overfed/overstocked aquaria, and their high dollar value ($10-$30 USD each), *Berghia* are highly desirable candidates for the aquarium trade.

It is interesting and noteworthy to mention that the reason *Berghia* are needed in the first place is

both ironic and avoidable. If aquarists would quarantine all new livestock (not just fishes... but plants, algae, live rock, sand, corals, etc.) and did not overstock or overfeed their systems, then *Aiptasia* would be an almost unmentionable concern. Nuisance anemones do not grow from thin air, or sterile water as it were, but need food and nutrients to survive. When they are not properly screened in quarantine, and then introduced into a conducive aquarium system - only then do they proliferate. The all-too- common realities of busy or neglectful aquarium keepers are the things that *Aiptasia* thrive on: poor water flow (less than 10-20X minimum turnover), which allows particulates to accumulate and settle to feed anemones, overfeeding and/or overstocking, poor lighting which allows pest *Aiptasia* to outcompete more demanding and desirable organisms (like corals, plants, macroalgae) for nutrients, and poor nutrient export mechanisms (neglect of a well-tuned skimmer, weekly changes of carbon/chemical filter media, frequent water exchanges, etc.). Further compounding the problem, *Aiptasia* are naturally prolific and successful in reproductive strategies. With adequate light and food they multiply rapidly by budding and pedal laceration. With inadequate light (even darkness!) they will issue numerous asexual buds that drift with the purpose of surviving elsewhere [note: imposing dark cycles is a way to successfully exploit this anemone into producing smaller *Aiptasia* to feed small *Berghia* in culture]. We may have to bow with chagrin, but *Aiptasia* will continue to be an ever-present inevitability in the aquarium trade, and *Berghia* are direct solutions to this pest organism.

It is not uncommon to find *Berghia* patrolling the edges and underside of the water's surface.

Notice the very pale color of this *Berghia* that has not fed on its favored cnidarian prey in days. After a good meal, its cerata ripen in size and darken in color.

Right: The aftermath of a *Berghia* attack is not pretty. Each *Aiptasia* preyed upon is usually reduced in a matter of hours.

Left: *Berghia* become conspicuously stout after a good meal with swollen cerata and a noticeably inflated or elongated body. Although regarded as "photosynthetic" for eating and utilizing the zooxanthellae of cnidarian prey, *Berghia* cannot be sustained by illumination alone. In culture, one must offer a regular, if not continuous, supply of *Aiptasia* (several times weekly, if not daily).

Handling

One of the biggest obstacles to the care and culture of this sea slug has been their small adult size and vulnerability to common aspects of aquarium filtration, e.g. pumps, overflows, etc. Similarly, hatched juveniles cannot be clearly seen with the unaided eye for many weeks' time after hatching, perhaps

up to two months. And subadults are commonly shipped at ½" (12.5 mm) and are still rather physically delicate to handle. For those receiving shipped *Berghia*, please note that it is best to simply sink the transport bag or cup into the new vessel for a gentle acclimation of 15-20 minutes and then allow the sea slugs to crawl out on their own volition. All of this is to be done without illumination as a comfort to their nocturnal tendencies.

It should also go without saying that the culturing vessels should be well-established with aged water for some weeks in advance before seeking specimens. Newly mixed seawater is harsh to many reef creatures... but particularly so to invertebrates. Also, do not underestimate the need to have a significant supply of *Aiptasia* on hand; hundreds of anemones will be needed to support a single pair of *Berghia* for the first few months.

Any realistic plans for keeping *Berghia* at any size will necessarily embrace a specialized system at the start. I strongly recommend that all new *Berghia* be acclimated in isolation. An appropriate home for them could be as simple as a floating plastic cup or beaker, or something as elaborate as a refugium. The pitfalls of the latter, however, will likely include a pump or overflow at minimum. I recommend glass beakers or plastic cups submerged partially in a temperature-controlled aquarium. Note: it is critical to keep these containers tightly covered to reduce evaporation, in which salinity can stray quickly and fatally to the nudibranchs in such small volumes of water.

Isolation gives these small creatures a little bit of time to acclimate to the aquarist's water quality and schedule of husbandry. Aquarists interested in culturing *Berghia* must naturally engage this species in monospecific culture. Others who seek only to reduce nuisance populations of *Aiptasia* in another system or display will still want to isolate new *Berghia* at first to give them a good start. Small rocks covered with *Aiptasia* can be placed in the culturing vessels for the first few weeks until *Berghia* become established. **Placing newly purchased *Berghia* directly into a display tank is not recommended** - they will almost certainly die or be killed by any one of a number of pitfalls in the aquarium before they completely eradicate plague *Aiptasia* populations.

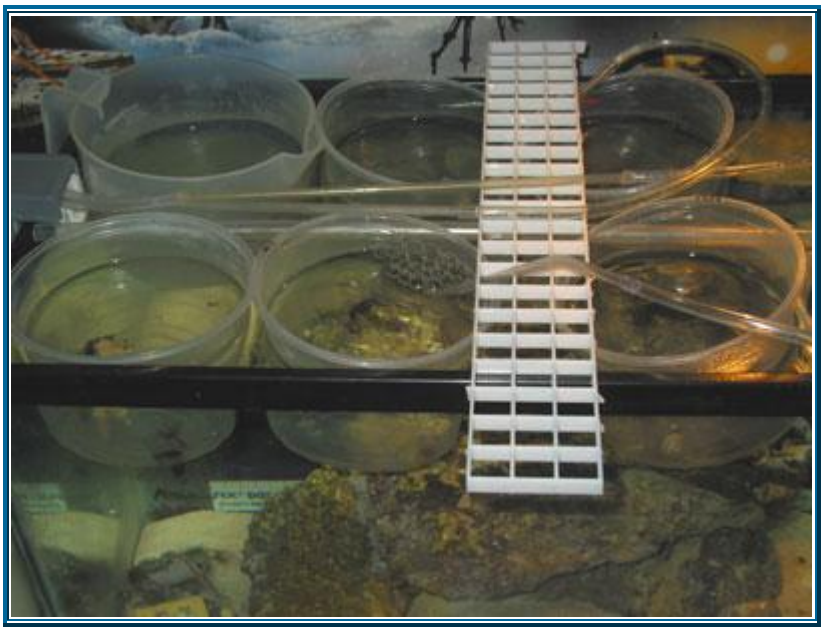
The bane of many aquarists: nuisance *Aiptasia* anemones, which can reach plague proportions in aquaria.

Many common community fishes and invertebrates will damage or eat small "nudis" out of curiosity if they are simply dropped into an aquarium. There is also the concern that they will fall to the perils of high water flow, and the aforementioned pitfalls of pump intakes, overflows, etc., before they can establish themselves and breed. Considering how expensive they are to acquire, it only seems

it takes to collect egg masses from active breeders. A little patience with quarantined *Berghia* in this case can easily translate into tens or hundreds of propagated nudibranchs to fight the *Aiptasia* battle for which they were purchased.

In light of all of this, the relationship between *Aiptasia* and *Berghia* begs a question that Eric Borneman (1998) and others have raised on the subject before, "Can we expect *Berghia* to completely decimate populations of *Aiptasia* in our aquariums and if so, what happens to the nudibranchs when they do?" It's a matter of inverse predator-prey relationship: *Berghia* flourish (population goes up) while consuming *Aiptasia* (population goes down) and then high densities of *Berghia* can no longer be supported and crash (population goes down) while *Aiptasia* recover (population goes up). The dynamic is played out in countless ways throughout the living world between other organisms in predator-prey relationships. Recent studies, for example, have claimed to dispel the remarkable natural phenomenon of cyclical die-offs of rodent lemmings by this "boom or bust" population rhythm. The sometimes-sudden (100-1000-fold) expansions in lemming populations are intimately linked to the numbers of four specific predators, one of which (the stoat) is key as they prey upon the rodent to exclusion among possible prey, like *Berghia* do upon *Aiptasia*.

An infinite supply of *Berghia* in any display is not assured, or even likely, without assistance from the keeper. A spike of prey, then spike of predator, then drop in prey, and subsequently a drop in the numbers of predators can be expected. Unlike wild habitats, however, the home aquarium is not a balanced ecosystem and we cannot expect that some *Berghia* will always weather the cycle. As such, I cannot repeat and recommend strongly enough the importance of the need for maintaining broodstock of *Berghia* even for aquarists that merely wish to control *Aiptasia* in a display (versus culture the nudibranchs). Neglect of this admonition would be a waste of a living resource and, at best, require that the keeper repeatedly buy *Berghia* with the "boom and bust" cycles of prey over time to control their pest anemones.



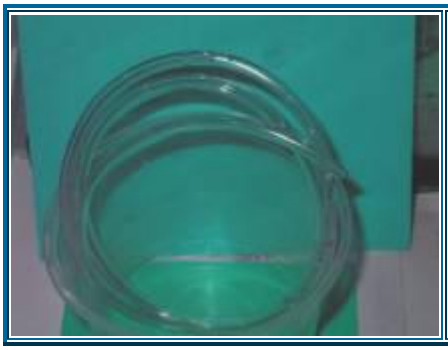
A culturing system for *Berghia* is inexpensive and simple. Aquarists commonly use beakers or floating plastic cups with gentle aeration to keep adults. Be mindful to control evaporation in these small vessels, though. **Note**: cups are uncovered in this picture, but must be tightly capped to prevent fatal salinity increases due to evaporation.

Housing

Most anyone with experience culturing *Berghia* will recommend the same thing regarding housing: it's best and easiest to grow these sea slugs in small cups or beakers (250-1000 ml). The challenges of

concentrating, feeding and locating such tiny organisms in even the smallest aquaria otherwise are daunting. Plastic cups floating in thermostatically controlled aquariums seem to work very well for this purpose. Rods, pipes, or lines can be used to cordon off the floating vessels at the surface so that they don't bump around or capsize in the display. All containers resting on a submerged PVC "table" is better still. Water quality can be a bit of a challenge in small cups due to evaporation, so its important to mark the sides of the cups or beaker with a line to indicate where to top off the vessel with distilled or RO/DI water to compensate for evaporation. Keeping lids or covers on culturing vessels will also be very helpful for slowing evaporation and the resulting stress caused by fluctuating salinities. Frequent water changes will also insure optimal water quality (several times weekly for adults). The culture of *Berghia* in this manner is really quite easy and straightforward, but is admittedly tedious and indeed a part of the final price of the creature for the inconvenience of husbandry. Small lengths of flexible airline tubing and plastic or glass pipettes are handy for conducting water exchanges, removing debris/feces, and for transporting small *Aiptasia* between cups. In preparation for the arrival of *Berghia*, place a couple of *Aiptasia* in each of the cups that will hold the beloved Aeolid specimens. Be warned though that it is quite possible to have too many *Aiptasia* in a cup; they will compete for desirable elements in the water, and they can slough copious amounts of slime or mucus and degrade water quality. It's also best to let *Berghia* prey on just one or two anemones at a time in small cups or beakers for the obvious reasons (water quality).

Be mindful that vessels, instruments, hands and anything else that comes into contact with live *Berghia* are clean and free of contaminants. Nudibranchs, like many invertebrates, can be very sensitive to small concentrations of foreign substances and may suffer great morbidity or mortality from exposure to these substances. It's easy to overlook potentially fatal toxins like matter that might be under one's fingernails or on the hands, adhesives on equipment (e.g., glue left behind from the peeled price tag on a bit of submerged tubing), residues from used cups, or residual cleaning products on towels used near the culture system (transferred onto dried hands, or dipped into the water by accident). Larvae are particularly sensitive to these types of contamination. The rule here should be to cleanse hands and objects of the system thoroughly in pure freshwater only (de-ionized, if possible). Water changes on vessels with adults can simply be done by wiping out the walls of the containers and pouring off the old water before gently tipping in seawater from the tank of healthy aquarium water in which the culture cups float. After a pair spawns, it's usually best to remove the breeders to a new cup and leave the eggs undisturbed. Take note of the spawning date to track the progress of the egg mass(es) for hatching predictions and preparations.



Be very careful to use clean hands and clean instruments when working with *Berghia* - this small invertebrate in a small volume of water can be very sensitive to contaminants like soap from hands and towels, or adhesives from stickers or price tags on recently purchased equipment.

Culturing *Aiptasia* anemones?

Heehee... it sounds as funny to me writing it as it does to you reading it perhaps. But nonetheless, culturing *Berghia* will require an address of producing a consistent and adequate supply of food-*Aiptasia*. A novel way of producing small *Aiptasia* is to keep a broodstock population of the pest anemones in the dark for some weeks/months to produce tiny asexual buds. Feeding the anemones during this time will be necessary in the absence of light. Like many cnidarians, *Aiptasia* can be maintained under inadequate illumination by compensating with extra food. In overrun displays, it

is this very thing that is the catalyst for plague populations of the anemone: excess nutrients. As many aquarists know, it does not take much for illuminated and fed *Aiptasia* to proliferate. They can also be propagated by way of simple division... or rather, laceration. No doubt, they are challenging to eradicate from display aquaria and attempts at scraping or rasping them off the rocks has often met with dismal results as the effort only increases the numbers of *Aiptasia* for the buds formed by residual pedal tissue. Aquarists interested in culturing *Berghia* will inevitably want to set up a tank for co-culturing food -*Aiptasia*- for a controlled and reliable source of prey to offer.

Reproduction

Berghia reach sexual maturity early (at approximately 12mm) - long before they achieve full adult size. Eggs are laid in a characteristically spiral egg-casing fashion. Spawns may be deposited on or underneath a rock, if available, but can be found conspicuously on the aquarium or container walls just the same. Occasionally, the egg masses will be released in free-floating strands (often so, if they are disturbed while egg-laying). Reproductive events can be amazingly frequent at times with well-fed and well-conditioned young adults, occurring at a frequency of one egg ribbon laid every one to two days - per individual! Older specimens naturally slow down and are less prolific. It is possible to start with one pair of *Berghia* and have a couple hundred individuals in just a month or two. As you can imagine, the need to provide adequate supplies of *Aiptasia* to feed such colonies soon turns your problem from an *Aiptasia* plague to a *Berghia* plague! Fortunately, *Berghia* are so highly prized that it is not difficult at all to find wanting and waiting homes for your surplus juveniles through local channels or online. In kind, it is not difficult to find fellow aquarists locally with *Aiptasia* covered live rocks to share. Recruiting food for your *Berghia* may be as simple as exchanging clean rocks for anemone covered rocks pound for pound with other aquarists delighted to get rid of their nuisance anemones. Nonetheless... home culture of *Aiptasia* is still necessary as a more reliable means of insuring adequate food supplies for the Aeolid.

A freshly laid *Berghia* spawn has a crisp and clean appearance
with clearly distinguished tiny eggs within the strand.

Berghia are truly ideal and profitable specimens for the cottage industry of reef invertebrate reproduction. Which brings us to another wonderful aspect of this Aeolid's anatomy - they are hermaphrodites, which spawn reciprocally and take turns fertilizing each other eggs. (***note***: self-fertilization and fission are rare by comparison). Courtship is a conspicuous dance (OK... a slow dance) with two individuals in a spiral "embrace." If you think it looks like your mating pair are necking, you are not mistaken. The genital openings on *Berghia* are on their right side (notice their

heads must be very close together for the successful alignment of copulatory apparatus.

This series of three images shows the characteristic circular "dance" of courtship that leads to the (usually) reciprocal genetic intromission of gametes between *Berghia*. Genital openings are near the head on the right side of this Aeolid, just behind the rhinophores/cephalic tentacles.

The larvae of *B. verrucicornis* are **lecithotrophic**; metamorphosis occurs soon after hatching, which makes aquarium culture much easier than species with extended larval stages. In layman's terms: hatched larvae do not have a long or complicated stage or series of stages of development as plankton, but are non-feeding and settle out to the seafloor rather quickly to begin feedings like adults, in a matter of days. As such, the aquarist is spared the tedious co-culture of specific larval foods like with so many other reef organisms that have feeding planktonic stages. Very small *Berghia* simply eat very small *Aiptasia* - or, at least, they will develop faster and easier in captive culture if spared the monumental task of wrestling large, oversized *Aiptasia* once they begin to feed. Make no mistake, this predatory sea slug can, in fact, be prey for *Aiptasia* in some circumstances such as poor acclimation techniques where *Berghia* are poured into the aquarium and dropped into the open and waiting tentacles of a hungry anemone! Young *Berghia* forced to contend with oversized *Aiptasia* may even be observed to pull back, as if rebuffed, on an approach to the anemone and may consequently decline a feeding opportunity.

To the aquarist's further advantage, larval *Berghia* hatched in *un*-aerated vessels may navigate the planktonic stage and settle out faster to begin feeding on anemones. My limited experience rearing hundreds of these nudibranchs does not yet dispute this theory, and I'm eager to examine the issue more closely in time. At least one reference cites excessive aeration of egg-bearing containers as an impediment to proper embryonic development. At any rate, rest assured that adults and egg masses alike need little or no aeration when water quality is kept well via regular water changes and due diligence with evaporation compensation.

Berghia eggs begin to hatch after approximately 10-14 days. They take on a milky or hazy appearance at that time which may be used as an indicator for opportunities to artificially hatch them with the pumping motion of a pipette.

Egg ribbons will hatch in 10-14 days depending on temperature (a range of 76-79° F/ 24-26° C is recommended). It will be some weeks before the juveniles can actually be seen with the naked eye - about two months, in fact. Nonetheless, keep small *Aiptasia* in the culturing vessel and observe the decline of the hardy anemones as evidence of predation. It may be helpful to artificially hatch the egg capsules by "pumping" them into and out of a pipette repeatedly. The rasping motion will rupture the casing and liberate the larvae. It's difficult to say exactly when is best to conduct an artificial hatch in this manner. After some time and experience though, the aquarist will notice that after 9 or 10 days, the egg's casing takes on a milky or hazy appearance with embryonic development and growth (versus the crisp and clear appearance on day-one with tiny "dots" in it).

A soft plastic pipette is indispensable for *Berghia* culture. It is used to slurp detritus and debris from inside a cup, rasp eggs for artificial hatching and to conduct small water changes.	

One of the biggest obstacles to rearing *Berghia*, as mentioned before, is providing enough *Aiptasia* of suitable size. The failure of juveniles to develop cerata is often attributed to attempts to feed anemones that are too large for juvenile *Berghia* to successfully attack. Lacerated adult anemones may be helpful in the absence of an adequate supply of small *Aiptasia*. Nicking, notching or shredding the pedal base of feed-anemones opens the door, so to speak, for tiny *Berghia* to begin feeding, as well as facilitates reproduction by pedal laceration with any tissue left alone long enough to regenerate.

Note: it is a common and potentially fatal error by breeders of *Berghia* to sell offspring that are too young and too small. I have seen cultured specimens sold so small that half a dozen could fit on the tip of a pencil eraser... some are even sold without well-developed cerata! This practice is both poor business and poor husbandry. The aquarist is advised to simply stall the launch of his sales/business/trade in cultured *Berghia* by as many weeks as necessary for proffering larger and more stable specimens. I recommend shipping at 10-12mm minimum size.

Please be sure to explore the references listed in the bibliography of this article for further insight and perspective on the genus *Berghia* for aquaria.

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If you have any questions about this article, please visit my author **forum** on Reef Central.

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Tank of the Month

January 2004

Brad Whitney's (nvert) Reef Aquarium

Introduction

First and foremost, I would like to thank the folks over at Reef Central and *Reefkeeping Magazine* for selecting my tank to be the first Tank of the Month for 2004. What an honor it is! There are some truly amazing tanks out there that are obviously well taken care of by committed (and oftentimes obsessed!) reef hobbyists. As I've frequently drooled over past tanks of the month, it's actually a dream come true that mine is also being recognized, especially due to it's small size, simplicity, and economy.

Background

I'm relatively new to reef keeping, however I have kept fish since childhood. The reef tank you see today is only an evolutionary snapshot of an on-going fascination with all things wet. My first experience in marine husbandry occurred while growing up in southwest Florida where I had easy access to the inter-coastal waterways surrounding the Ft. Myers area. The variety of wildlife that I encountered amongst the waterways, beaches, mangroves, and islands definitely held my fascination. My brother and I, who is presently working off Sanibel as a charter-fishing captain, would frequently catch shiners and crabs and bring them home to keep in jars and bowls. Eventually, by high school I was keeping a 20-gallon marine aquarium using a gravel bed with undergravel filtration. I had a dwarf lion, flame angel, mandarinfish, *Chromis*, and other sorts of fish not appropriate for that size tank or combination. The tank was broken down for my move off to college but I resumed keeping fish, this time African Cichlids from Lake Tanganyika. At this point, I was determined to create the best possible environment for these guys, so I researched and created as accurate as possible a simulation of the rock environment they are found in. It was a great tank, but the saltwater bug still infected me and upon visiting a particular fish store in Columbia, South Carolina, while looking for a particularly rare cichlid, I was bitten 'big time' by the reef bug. Their displays were incredible and after inquiring about how to actually keep a mini-reef and seeing the systems in operation behind the scenes, I returned home and changed my 40 gallon cichlid display over to a full, blown reef environment. Live rock and sand was added to the tank late in March of 2002. The hobby of marine aquarium keeping sure has changed within the past ten years!

Design Concept

I had a few constraints that dictated how I approached the design of my system. First, because of costs, I decided to keep the 40-gallon breeder as the display tank. I constantly drooled over larger systems that I would see on Reef Central, but after seeing Tim Herman's (Therman) 40-gallon **display**, I was encouraged that my relatively small tank size could become a showpiece as well. Second, I just detest the look of a huge piece of furniture dedicated to a tank...much like an entertainment unit for a TV. The scale of this type of furniture would be too large for the room the tank would occupy. It was important for me that one would see the **tank** and not a huge piece of furniture or lots of equipment lying about. So, I decided to go without a sump and, instead, relied on a hang-on-the-back type skimmer and refugium **system**. The tank sits on a black, wrought iron stand, the lighting is suspended above, and the **ballast** rests on a black file cabinet that is, for the most part, hidden by the arm of the sofa. When walking into the room, all that one really notices is the tank.

Overall, the system is based on simplicity and economy. Because of this, I've discovered several pros and cons of such a design along the way. Over the last year, I have learned to let the tank work **for** me rather than the other way around. In any event, the final consideration dictating the design of my system was to establish a routine so I could enjoy, rather than constantly work on, my tank and this came with more experience rather than planning.

Aquarium Profile:

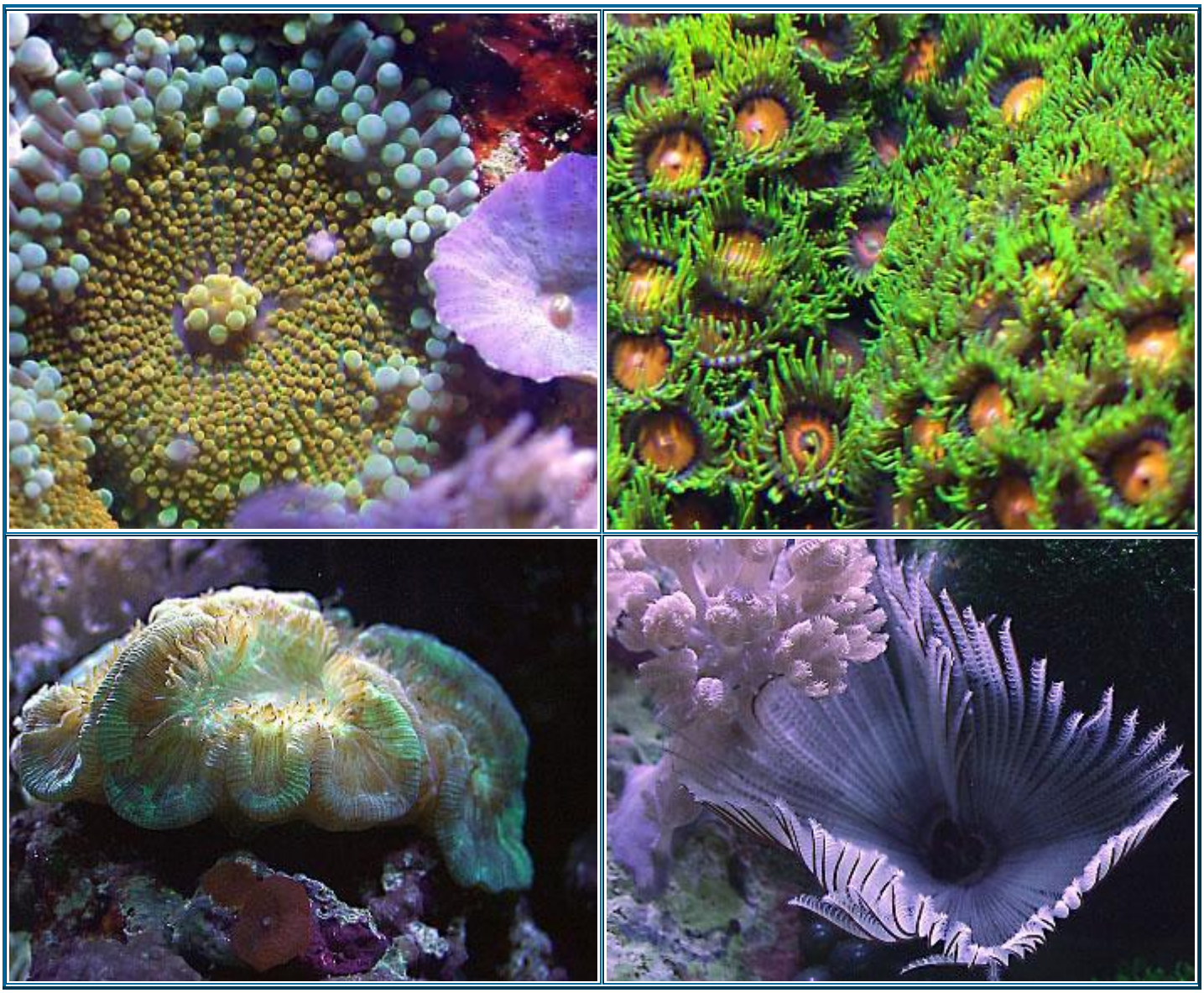
- **40-gallon breeder All Glass Aquarium**
- **Dimensions: 36" x 18" x 16"**
- **Free-standing iron tank stand, 36" x 18"**
- **H.O.B. skimmer and refugium**

Filtration and Circulation

In my research, I learned that live rock is the basic (and efficeint) means for nutrient export and breakdown in reef tanks, and the tank contains approximately 75 lbs. of Fiji live rock. Needless to say, the tank is full of rock and I was teased early on by friends that I would later on have no room for corals. To supplement the live rock filtration, I have a not-so-deep sand bed... approximately 50 lbs. of pink Fiji sand, which in turn creates a 2" deep bed on average. Due to the powerheads and my 7" *T. derasa*, the sand gets blown around quite a bit and in some places there is a 4" sand drift, while in others (especially under the *T. derasa*) there is practically no sand. In addition to the rock and sand, a small CPR hang-on-the-back refugium is used to grow macroalgae to help with nutrient export. There is also about a 4" sand bed in the refugium. The CPR Bakpak 2 protein skimmer does a good job of removing wastes, and the collection cup needs emptying about once every five days. Since the tank's initial cycle, I have had zero ammonia, nitrite, and nitrate readings using Salifert test kits.

The water column is circulated via three powerheads. A Wavemaster Pro wavemaker controls two Maxijet 900 powerheads located in the upper left and right rear corners, forcing the water inwards toward the center of the tank. There is also a Maxijet 600 located in the lower right rear corner that forces water movement behind the reef/rock structure along the back glass of the tank. The skimmer (located on the left side of the tank) and an old Whisper 4 power filter (used mainly for circulation and containing a collection of rock rubble, centered on the tank) are also controlled by the Wavemaster Pro. The refugium hangs on the right side of the tank and is operated independently of the Wavemaster. This is one area where I wish I had included a sump in the design... a sump and a

tank matures, coralline algae, polyps, zoanthids, and other organisms are nicely encrusting the components.



Lighting

My lighting setup was originally inspired by David Playfair's **tank**. I love his mixed reef environment and his experience is proving that a bazillion watts is not needed to grow awesome corals. Since my ultimate goal was to have a mixed reef environment, I decided on a metal halide/VHO bulb combination, and I currently run dual 175 watt 20K XM bulbs supplemented by two 95 watt VHO actinics retrofitted in a Hamilton hood, which is cooled by a PFO variable speed fan. Both the halides and VHOs are run on standard ballasts. Originally, I began with a single 175 watt 10K Ushio bulb, but I didn't like the effect of the exceptionally bright center and dark corners caused by the single bulb... just too much contrast. The light spread provided by the dual metal halides is much more even and soothing to the eyes. One would think the additional bulb would make the tank visually too bright, but in reality it reduced the amount of contrast throughout the tank. Like most reefkeepers, I am constantly tweaking my system and I eventually changed out the 10K bulbs for 20K's, just to see what would happen. It took about 10 days for the bulbs to truly burn in, and during that time the tank honestly looked a little too blue. But after the burn in, and as my eyes adjusted, I started noticing pronounced positive affects on all the corals. The growth rates of my corals never did slow, in contrast to what some aquarists have observed under higher Kelvin bulbs, but boy, did the colors ever become more saturated! The XM bulbs have been running now for three months and I am very happy with the results so far. I stagger my lighting schedule and I especially like how the left and right halides come on and off at different times, much like the rising and setting of the sun.

Lighting Schedule:

- 11am: Actinics on
- 12pm: Left halide on
- 1pm: Right halide on
- 11pm: Left halide off
- 12am: Right halide off
- 1am: Actinics off

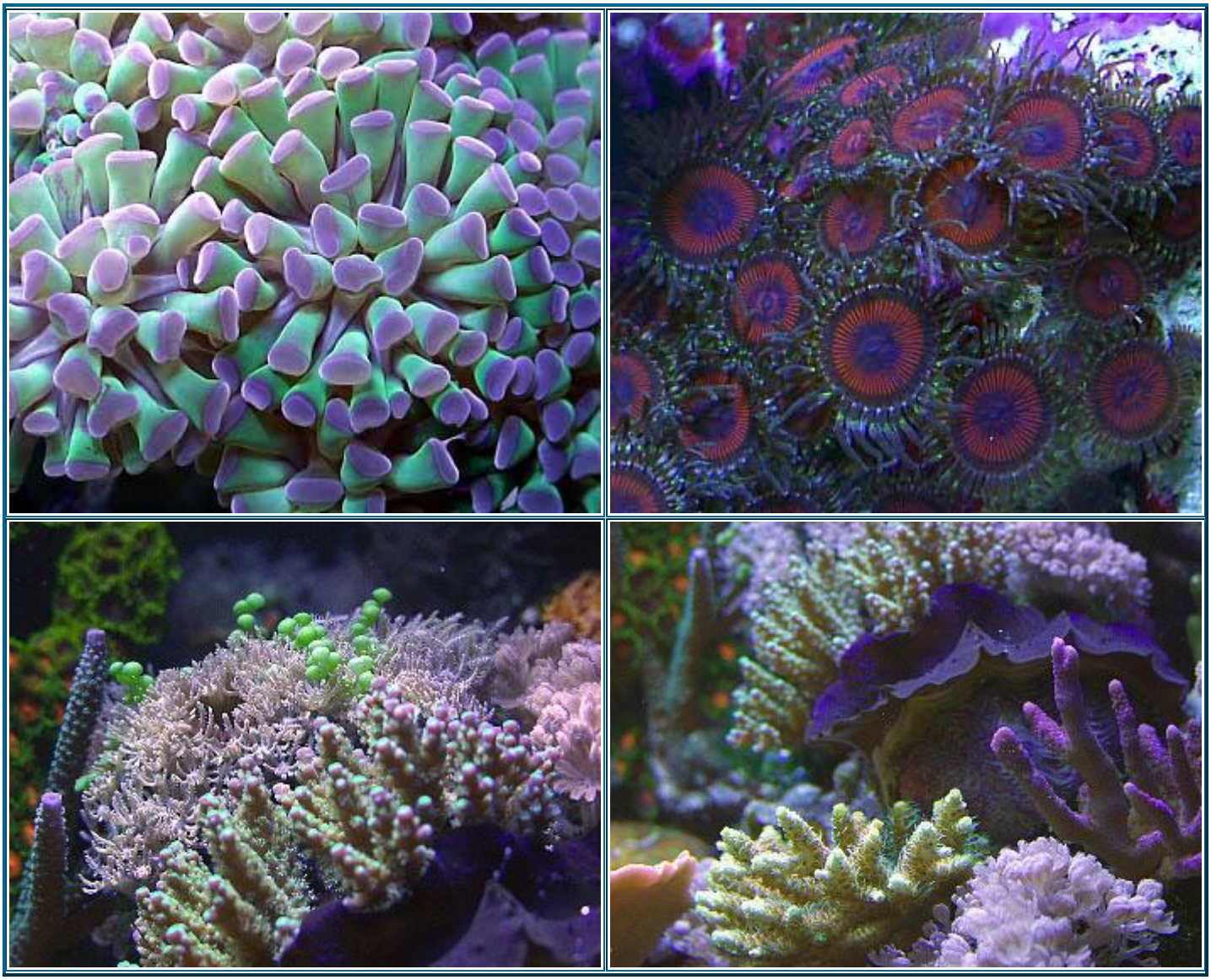
Refugium: 14 hour reverse daylight photoperiod.

Additives and Supplements

Water Parameters:

- **Calcium**: ~430ppm
- **Alkalinity**: ~9.0 dKH
- **Specific Gravity**: ~1.025
- **Temperature**: 79 - 83°F
- **pH**: ~7.9 - 8.3

As more and more calcium demanding corals were placed in the tank, I experimented with a variety of dosing methods. At first, I found B-Ionic to work the best for me, but the daily chore of dosing, not to mention teaching my house sitters how to dose while I went on vacation, became a chore and a concern. As I mentioned earlier, I'm frequently plagued with a case of "the lazys," so I needed to come up with a more efficient method of dosing. I have found that dosing Kalkwasser using a Vario peristaltic pump works great. I make up a three weeks' supply using 25 gallons of RO/DI water plus 250ml of vinegar and 14 tablespoons of kalk powder. The 25 gallon tub sits on the floor adjacent to the tank (a downside to not having a finished tank stand) and the solution drips at night, replenishing all evaporated water, and boosting the calcium and alkalinity levels. When I first experimented with dosing kalkwasser, my pH was all over the map. With the help of Randy Holmes-Farley, I found that a little vinegar keeps the pH in check. I have been using this method for over a year and my pH, calcium, and alkalinity ranges are constant.



I have tons of *Xenia*. **Tons!** For better or for worse, I finally gave up and let it go wherever it wants, whenever it wants. The upside to this is that it fills in between the hard corals, making for a very nice display. The downside is that it needs pruning every other month and it's my belief that it also depletes iodine rather rapidly. I also noticed the mushrooms began to lose color and not open up, and I attribute this to the iodine depletion. So, in addition to a nightly dosing of kalkwasser, I dose 5ml of Kent iodine each Saturday. The mushrooms responded to this additive perfectly.

Husbandry and Maintenance

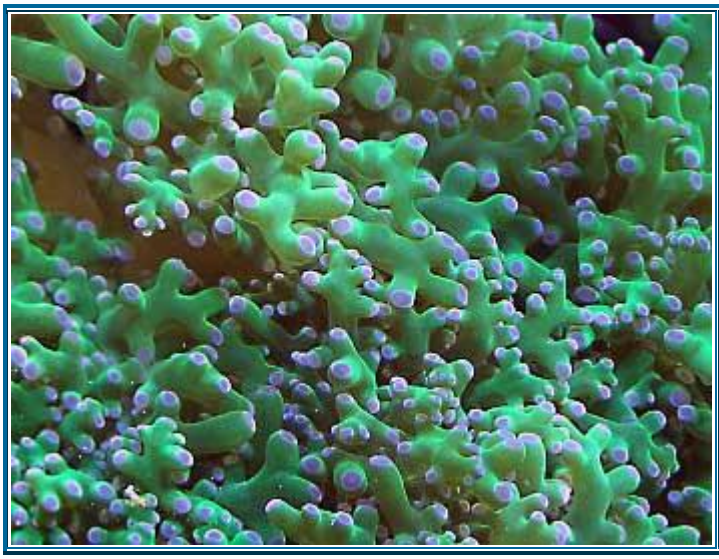
To my surprise, the tank needs very little in the way of maintenance other than the supplementation with the additives mentioned above. My biggest obstacle to overcome was simply establishing a consistent work routine to keep the water parameters constant. This took well over a year for me to learn. However, from day to day, I just clean the algae film off the inside glass and fingerprints off the front. I also clean salt creep off the equipment and the top edge of the tank as needed. The skimmer cup is emptied about once every five days or so, cleaning it under hot water with a toothbrush. Every two to three weeks, I do a 5 gallon water change using RO/DI water and Instant Ocean salt mix. I only once had a hair algae problem and that was during the tank's initial cycle before the hermit crabs were added. I occasionally have problems with brown wafer algae and *Valonia*, but in my mind, as long as these algae types don't get out of control, they make for a more natural appearance in the tank.

Feeding

I feed the tank fairly heavily. The fish are fed small pinches of flake food anytime I sit down to watch the tank. This gets them used to people, and boy do they beg when someone is in the room! Also, every evening I feed the tank one thawed cube of either frozen Prime Reef, Formula One, or Reef Cuisine. I target feed the *Tubastraea*, open brain, yellow polyps, *Fungia*, bubble-tipped anemone, serpent star, and the shrimp and hermits using a DIY feeder made from a Salifert syringe and rigid tubing. About twice a week I skip feeding the tank the frozen cube in order to give the tank a little break from all the organics going in. I have in the past made my own food... a combination of Sweetwater Zooplankton, chopped squid, *Mysis* shrimp, nori, and flake food with a little bit of Selcon™ added, but I generally rely on the ready-made food items due to convenience.

Occupants

My tank is predominantly a hard coral, mixed reef. Most of the corals below are small in size, the largest being the green *Favia* on the bottom of the tank. All of the *Acropora* were purchased as fragments from fellow reefers, such as Patrick Monaghan and David Playfair. Most of the other corals of the branching type also were aquacultured as fragments while all of the soft corals are fragments that I either purchased or traded for. I cannot confirm the history of the *Favia*, *Turbinaria*, *Trachyphyllia*, or the *Tubastraea*, but I suspect that they were collected from the wild. Because of the density, I am constantly trimming and cutting back corals, and I have recently reached a point where I frequently trade and sell fragments to local reefkeepers. There are many territorial battles taking place and it's interesting to see how some corals establish a neutral zone while other corals aggressively attack one another.



Corals:	
Acropora tortuosa (blue)	*Acropora valida* (tri-color)
Acropora yongei	*Acropora* sp. (unknown, blue with purple tips)
Anthelia sp.	*Blastomussa wellsi*
Briareum sp. (green star polyps)	*Euphyllia divisa*
Euphyllia ancora	*Euphyllia glabrescens*
Favia (moonstone, red with green centers) sp.	*Fungia* (short tentacle) sp.
Gorgonian sp. (purple with white polyps)	*Millepora* spp. (3 types: blue, pink, and yellow)
Montipora capricornis (orange)	*Montipora digitata* (3 types: orange, purple, green)
Mushrooms (blues, reds, greens, stripes, hairy)	*Pavona decussata*
Ricordea yuma	*Sarcophyton* sp.
Seriatopora caliendrum	*Stylophora* (green polyps) sp.
Turbinaria (yellow cup) sp.	*Tubastraea* sp.
Hydnophora sp.	*Trachyphyllia geoffroyi*
Xenia sp.	*Parazoanthus* sp. (yellow polyps)
Zoanthids (red, orange, green, yellow) *Zoanthus* sp.	

Other Invertebrates:	
1 *Tridacna derasa*	1 *Tridacna crocea*
1 Rose *Entacmaea quadricolor*	2 *Lysmata amboinensis* - Cleaner shrimp
1 *Thor amboinensis* - Sexy shrimp	1 *Clibanarius tricolor* - Hawaiian blue leg hermit crab
1 *Paguristes cadenati* - Scarlet hermit crab	5 Unknown hermits collected from Myrtle Beach
1 *Strombus alatus* - Fighting conch	1 *Neopetrolisthes maculata* - Porcelain crab
1 *Ophiomyxa* sp. - Tiger brittle star	Various *Astrea* sp., *Nassarius* sp., *Cerithium* sp. snails
1 Chiton that came on live rock (fascinating critter that I only see at night about once in a blue moon)	

Fish:

Many reef keepers may feel that I have a high bio-load and the seven fish that I currently have do contribute immensely to this. However, my ammonia and nitrate readings steadily remain at zero. I selected these particular fish based on their different color, shape, and patterns. Since they all occupy very different niches on the reef, they do not compete for food or territory in my tank.

Fish:	
1 *Premnas biaculeatus* -Maroon clown	1 *Nemateleotris decora* - Purple firefish
1 *Sphaeramia nematoptera* - Cardinal	1 *Synchiropus picturatus* - Psychedelic mandarin
1 *Chromis xanthurus* -Yellow-tail blue damsel	1 *Pseudanthias* sp. - Anthias
1 *Gobiodon okinawae* - Yellow clown goby	

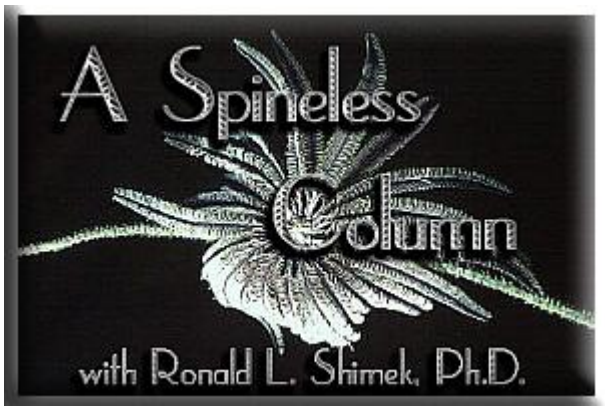
Wrap Up

Because of the rate of growth and number of animals in my tank, I have planned to upgrade the tank and all systems in the Summer of 2004. I'm not necessarily interested in adding more corals, I simply would like to see what I presently have grow larger. Upgrading the system, which includes turning this 40-gallon tank into a sump, will definitely take a little stress off the inhabitants. Thanks for taking the time to read about my tank. Please feel free to visit my website and email with questions, thoughts, or suggestions.

Happy reefing!

To learn more about Brad's system, visit his website by clicking **here**.

Feel free to comment or ask questions about my tank in the forum for the online magazine.



Tie A Yellow Ribbon (Worm) Around The Old Reef Rock...

Introduction

Over the past couple of years, I have devoted several columns to the various kinds of segmented worms found in reef aquaria. The bodies of these worms are composed of repeated body units which are generally manifested on the outside of the worm as a series of rings or annuli. The name that scientists give this great group of worms is the Phylum Annelida, recognizing that the "annuli" or segments are the worm's major visible characteristic. Most annelids found in reef tanks are polychaetes, known to most aquarists as "bristle worms." These worms have a couple of other notable visible characteristics such as the presence of appendages off each side of the segments and tentacles from the head or other regions of the body. These annelids are often large and evident, and numerous species of them thrive in aquaria. After looking into their tanks when the "clean up crew" of bristle worms is active and visible, reef aquarists might be forgiven for thinking all worms likely to be found in their systems are annelids. However, upon reflection most aquarists would also count flatworms among the wormy denizens of their systems. These two types of worms are commonly the basis for much discussion amongst aquarists, as they are generally foreign to the average hobbyist. Nonetheless, they are common inhabitants of marine aquaria, as eventually most hobbyists come to realize.

Recently, however, a third variety of worm has occasionally been **found in reef aquaria**. These worms are moderately large, up to several inches in length. Unlike the annelids, they don't have segments, and they have no visible appendages such as tentacles or the small paddle-like parapodia off the sides. While these worms appear in some cases to look a lot like flatworms, they aren't flat. They are decidedly "meaty" and have some real depth to their length and width. And, unlike most free-living flatworms, they may be quite large; in nature some of them reach lengths well over 100 feet long. These are the ribbon worms. Unlike a lot of the other worms as well, many of them are strikingly beautifully colored, and well worth keeping if we get the chance.

What's in a Name?

Ribbon worms are placed by taxonomists in a group that goes by several names. The group is most commonly referred to as the Phylum Nemertea, but it may also be called the Phylum Nermertinea, the Phylum Nemertini or, alternatively, the Phylum Rhynchocoela. All of these names refer to exactly the same group of animals, and simply represent the names given to that group by different researchers at different times or in different countries. It is probably worth using this example to illustrate the arbitrary nature of taxonomy and the study of animals. Within any large scientific discipline, there are differences of opinion, and methodology. For example, the scientific discipline that most American reef aquarists would recognize as "marine

ecology" really doesn't exist within the same framework in Russia. While the science of marine ecology is present in Russia, the way in which it is studied and concepts emphasized as important differ significantly from what is studied, or even conceived of, in the United States. Likewise, taxonomy differs from place to place. In the middle part of the twentieth century, the American invertebrate zoologists and taxonomists who studied ribbon worms considered the worms' characteristic extensible prey-capturing proboscis, called a rhyncocoele, as the most important defining structural feature of the group. In use, the ribbon worm's proboscis projects in front of the worm rather like an elephant's trunk or proboscis. To emphasize that this notable feature had a contained space or cavity within it, some American invertebrate zoologists coined the term, "Rhynchocoela;" rhynchocoela literally means "cavity in the nose, or beak." These biologists then began to refer to the ribbon worms by that name. However, most other invertebrate zoologists kept referring to the group by its earlier name of Nemertea; a name derived from the name of the ancient Greek Sea Nymph or Nereid, known as Nemertes, "the unerring one." This was also an appropriate name for these worms in that the proboscis is unerring and always spears or grabs the prey. The name "Rhynchocoela" was used extensively in the United States and Canada until the 1970s when it began to fall out of fashion, nonetheless, it is still occasionally used. Presently, the older name of Nemertea is far more commonly used. In any event, should the reader become interested in this group, information about them will be found under all of the names listed above.

Shapes, Sizes, Structures and Functions

Ribbon worms don't have any manifestation of segmentation. Unlike the annelids, the body is smooth. They also lack appendages or any other permanent projections from the body. The body is often brightly colored, and there are often small dark eyespots found near the front end. On careful examination, a pair of grooves is sometimes found just behind the head, and the animal will be seen to have either one or two openings at the front end, and one opening at the rear end. They are typically long and thin, about the length and width of some ribbons, hence giving the group their common name. However, they are not flat like either ribbons or flat worms. The bodies are typically circular or elliptical in cross section. They really have only one claim to zoological fame. Some species of nemerteans may well be the longest of all animals. Nemerteans longer than 30 feet long are surprisingly common, and some have been measured at well over 100 feet in length. There is a nemertean story, probably apocryphal, about the eminent late nineteenth and early twentieth century British zoologist, **E.Ray Lankester**. Lankester was pretty much the dean of British scientists at the end of the Victorian period, and as one of his many perks, enjoyed golfing privileges at St. Andrews golf course in Scotland. During one round of golf, the eminent doctor whacked a ball into the rough, which as the golf course runs along the sea shore, was the intertidal zone. He is reputed to have gone in search of the ball, only to be distracted by finding a nemertean coming out of one hole and going into a second hole over 100 feet away. Neither end of the worm was seen, so the total length remains unknown, except that it was in excess of 100 feet long. Lankester also collected a sipunculan, or peanut, worm on one his forays into this golfing intertidal zone. It was new to science, and he immortalized his passion by naming the worm genus, *Golfingia*, but that is another story. Other nemertean worms have subsequently been collected with lengths similar to what Lankester found, validating his observations. Alas, the largest nemerteans that I have personally collected were only about 60 feet long.

Figure 1. The head of a large nemertean worm I photographed in about six feet of water near Seward, Alaska. The body of the worm was well over 40 feet (12 m) long.

The 550, or so, species of ribbon worms, are mostly marine, and most are found in the polar seas where they are often both diverse and abundant. However, they are by no means rare or uncommon in temperate or tropical habitats. While most marine forms are bottom dwellers, there are few species that are wholly pelagic, **swimming in mid-water**. There are a few species found living on the bottom in freshwater habitats. One species, called either *Prostoma rubrum* or *Prostoma graecense*, is widely reported from streams throughout North and Central America. There are also numerous terrestrial species, found mostly in the tropics, but at least one species of *Geonemertes* has been accidentally introduced to the west coast of North America and is now found from Vancouver, British Columbia, to San Francisco. It lives in and under leaf litter and is thought to prey upon small slugs.

Nemerteans have a misleading simplicity of structure. Superficially, they look rather like "unflat" flatworms. It is easy to look at small ones, particularly, and see a relationship to flatworms. After all, both flatworms and nemerteans are flattened (more-or-less) unsegmented worms, with no clear definition of a head or other body regions. They both move with the gliding type of movement characteristic of ciliary locomotion when small and by a combination of gliding and muscular movement when larger. Neither of these types of worms has a hard shell or cuticle, and both have similar simple eyespots. Internally, neither of these worm types has a body cavity surrounding the gut. All of these things have indicated to several generations of zoologists that nemerteans and flatworms are closely related.

Figure 2. A small individual of *Tubulanus polymorphus*, about six inches (15 cm) in length. This species may eat small crustaceans, and reaches lengths of about three feet.

Such a close relationship made for a pretty story and allowed a lot interesting theory and discussion about how nemerteans were somehow "advanced" animals at the flatworm structural grade. Unfortunately, such stories and discussions were well within the realm of science fiction. Close examination of internal structures, as well as studies of the genetic material of both groups, indicates no relationship at all. Nemerteans are descended from a totally different group of animals than those that gave rise to flatworms. Although ribbon worms may look like flatworms, the most recent ancestor they likely shared was alive over a billion years ago.

Ribbon worms are typically elongate worms with a circular or elliptical cross section. They have a ciliated epidermis which is the major means of locomotion for most of them. Cilia on the bottom surface move the animals in a gliding locomotion, in many ways similar to the gliding locomotion seen in many snails. These snails, such as individuals of the common aquarium snail, *Nassarius vibex*, also move by ciliary means. These worms are, however, also highly muscular, and the larger forms also use muscular means to move themselves along. They may pass muscular waves of contraction down their bodies using these to provide propulsive power. Some forms are very active swimmers as well. Most, however, use a combination of ciliary gliding and peristaltic muscular means for locomotion.

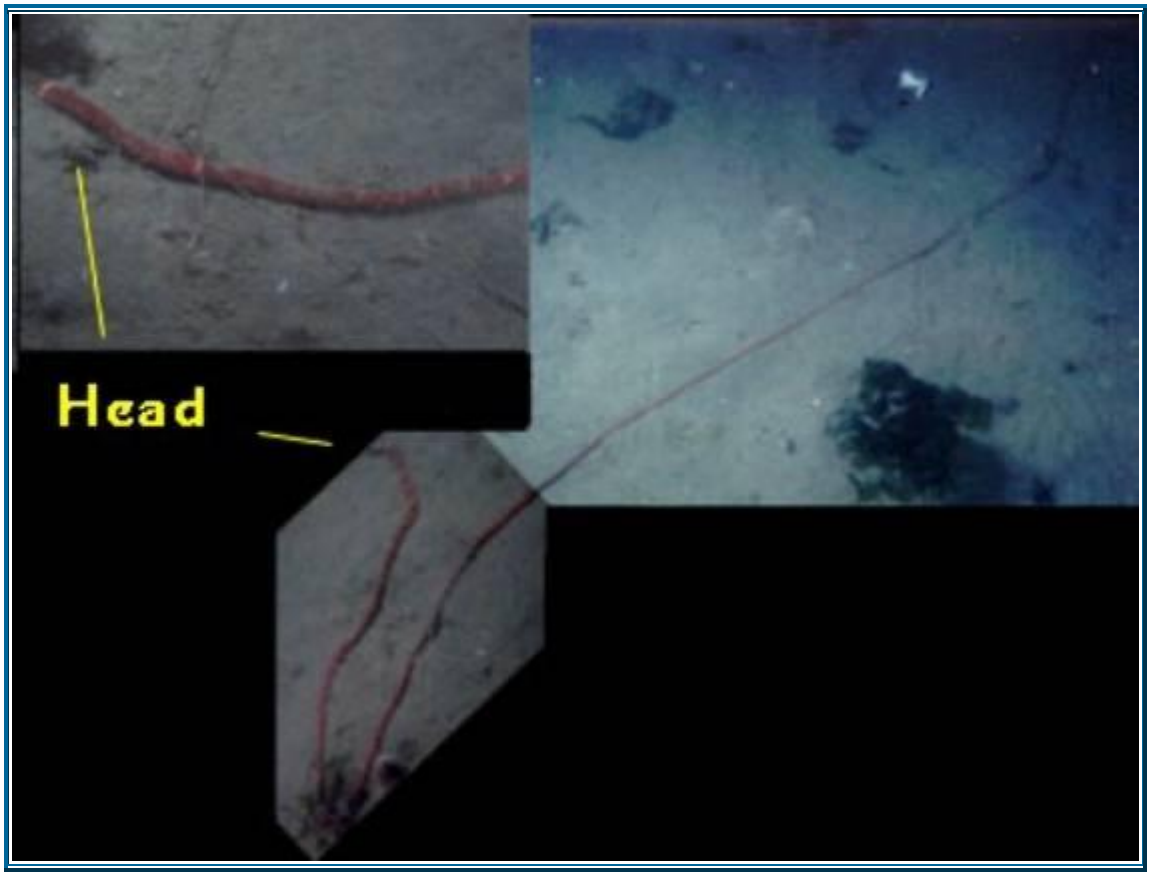


Figure 3. A composite of several images showing one individual of *Tubulanus albocinctus*. Common in the Northeastern Pacific, this species gets relatively large. The animal illustrated was about 20 feet (6m) long. Virtually all aspects of this species' natural history are unknown, including why they aren't preyed upon while foraging. The bright colors of many nemerteans may be "aposematic" or "warning" coloration indicating bad taste or some other deterrent against predation.

The internal anatomy of these animals is complex, but not as complicated as the average annelid worm. The gut is a complete gut with sequential digestion occurring from front to back in the gut. Unlike the gut found in flatworms, which has only one opening, the gut in ribbon worms has an anterior mouth and a posterior anus. The mouth may be found either at the front of the body, or on the bottom of the body a short distance behind the front end. The anus is generally terminal at the back end, although a few forms have a small "pigtail-like" cirrus projecting behind it. The gut has quite a few internal divisions, but they don't correspond closely to what is seen in many other animals. Behind the mouth is a short esophagus, often with a large pouch or caecum extending from it. Located just after the esophagus is the relatively small stomach, and then a long intestine extends almost all the way to the end of the worm. The intestine has many side pouches, referred to, collectively, as intestinal caecae. It appears that much of the digestion occurs within the cells lining the various pouches rather than in the gut cavity. A short hindgut terminates in the anus. The gut is embedded in the body musculature, and no body cavity is found surrounding the gut as it is in annelid worms, fish, or crustaceans.

The ribbon worms possess a closed circulatory system similar in concept to that found in annelids, fishes or, for that matter, humans. The blood always is found with vessels, unlike the situation in mollusks or crustaceans, where the blood flows freely over and through the tissues. There is a blood vessel loop around the brain region and lateral blood vessels which extend down the length of the body on either side, meeting at the posterior end of the body. Often, but not always, a dorsal vessel is found running from the anterior blood vessel ring to the juncture of the two lateral vessels. There is no heart, nor are there valves within the system. Blood simply sloshes around within the vessels and is moved by muscle contractions throughout the body. The blood may or may not contain hemoglobin, but if it does, the hemoglobin is not found in cells.

As befitting long and narrow animals with a permeable body surface, there are no specialized organs for respiration. Dissolved gases simply diffuse in and out over the body surface. Instead of using a high a high pressure filter system as a kidney, such as found in octopuses, these worms rely on a fine system of tubules with fluid motion dependent upon a few small clusters of beating cilia. Such systems are simple kidneys that are more adapted to control water balance than to excrete nitrogenous wastes. Nonetheless, they do secrete ammonium ion as a waste product. These kidneys empty through pores near the front end of the animal.

Although they seem like simple worms with not much going for them, they have a surprisingly complicated nervous system. They have a large bilobed brain with a major nerve running around the front of the gut, in the region of the throat. Instead of a single spinal cord, they have paired major nerves running the length of the body on either side. Additionally, large nerves run from the brain to the proboscis. They typically have eyespots, sometimes as many as several dozen. These eyespots cannot form images, but in the most sophisticated receptors can detect changes in light intensity and the angle of light impingement. Additionally, they have several well-enervated organs in the head region that are thought to be mostly chemosensory.

Their reproductive systems are simple to the point of being rudimentary. The sexes are separate, and the gonads are found as masses of egg or sperm producing tissue between the intestinal pouches. When the animals are gravid, and "the time is right," temporary openings form to the outside and spawning occurs. In a few nemerteans, such as *Cerebratulus* species, a specialized hat-shaped larvae, called a "pilidium" occurs. This larva develops and then undergoes a metamorphosis into a juvenile worm. In most nemerteans, the embryo develops directly into a small worm, and has no larval form. They also develop asexually by fragmentation.

Figure 4. A pilidium larva collected from the plankton. The juvenile worm starts development at different discrete points within the larvae. These all grow together

as the larva ages to eventually form a worm which will emerge from the larvae at metamorphosis. This larva was about 0.004 inches (100 µm) long.

Proboscis

The single structure that sets these worms apart from all other worms is their proboscis, the rhyncocoele. Basically, the term "proboscis" simply means a large, evident and sometimes mobile nose, such as an elephant's trunk. However, that really isn't the case with these worms. Here the proboscis is a rapid-strike prey capture organ. The nemertean proboscis is normally retracted into an internal sheath or pouch found above the worm's gut. The proboscis proper is a thin walled closed tube, shaped like a rather long, flexible, soda straw with a closed end. The open end is continuous with the body surface at a pore on the front of the animal. The closed end is held inside the sheath, pulled into the sheath by the contraction of a long muscle called the proboscis retractor muscle. The inside of the straw is continuous with the outside of the animal, and is collapsed on itself when the proboscis is retracted. The proboscis sheath is a closed impermeable tube and is filled with fluid. When the animal senses a prey organism nearby, a circular muscle layer around the proboscis sheath rapidly and vigorously contracts. This contraction forces the fluid from the proboscis sheath into the proboscis and, in the process, literally turns it inside out, blowing it out of the proboscis sheath. The proboscis will rapidly (within a second or so) wrap itself around the prey, which is then drawn to the mouth and eaten.

There are two basic types of nemerteans, and the difference between them is based on the structure of the proboscis. In the ones considered to be primitive, in what taxonomists call the class Anopla, the mouth is located ventrally, and the proboscis exits at the front of the worm. These animals have a poisonous or sticky proboscis secretion that acts to immobilize the prey, which is subsequently eaten. Some common genera of Anoplans are *Cerebratulus*, and *Lineus*. Ray Lankester's long nemertean found by the golf course was probably a species of *Lineus*. Some worms in the Anoplan genus *Cerebratulus* are notable for their swimming ability. They are flattened top to bottom and very muscular. They swim by undulating their bodies much in the manner of a sea snake or leech. I have had several of these worms, about two or three feet long swim by me, always on night dives in murky dirty water. It is enough to make one swear off alcoholic beverages...almost.

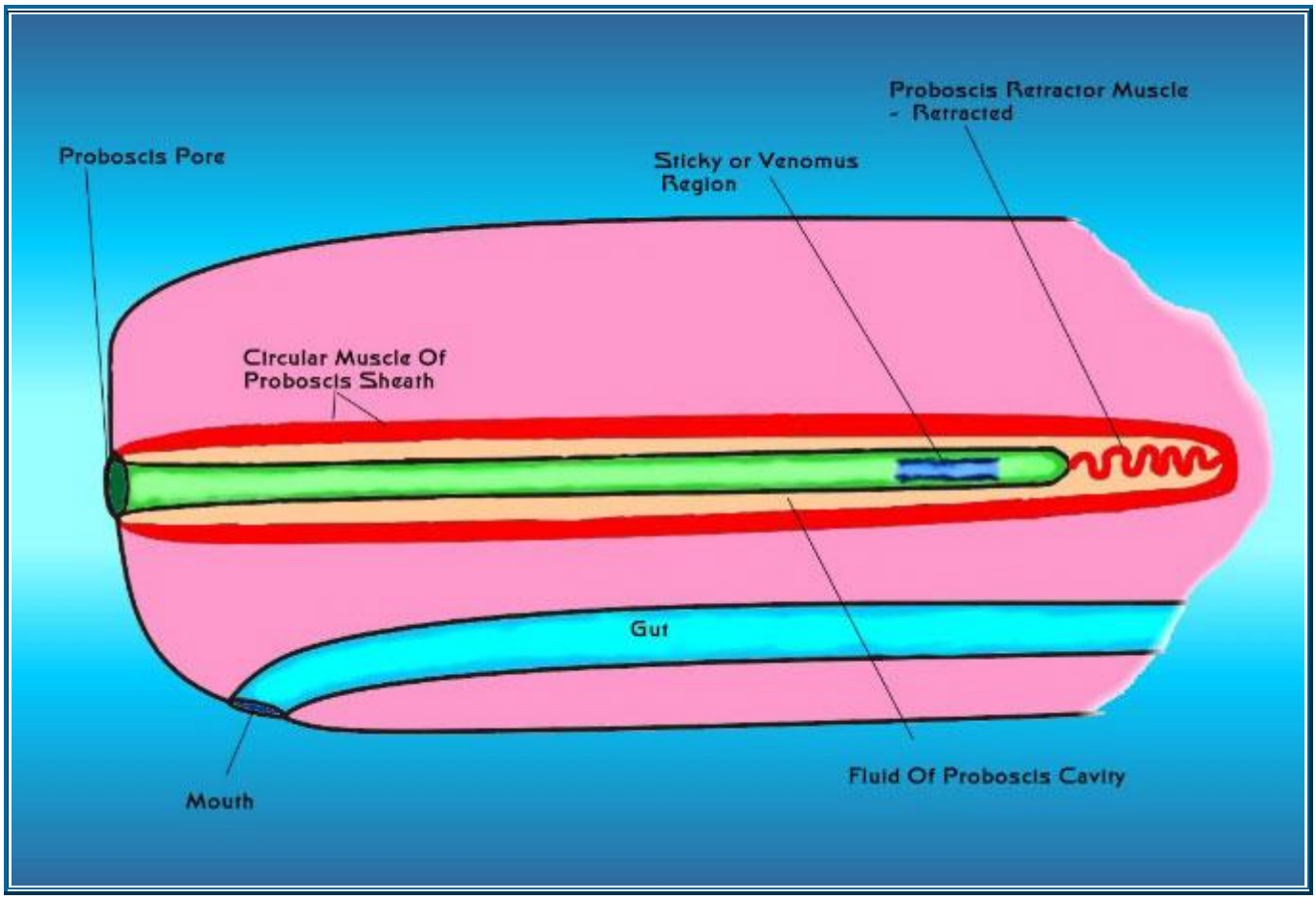


Figure 5. A diagram of the basic structure of the front end of an Anoplan (stingless) nemertean showing the retracted proboscis.

The other basic type of nemertean is placed in the taxonomic class Enopla. Here the gut and the mouth open through a common pore at the front of the animal. Additionally, they possess a piercing calcareous stylet which punctures the prey, introducing venom into it. The stylets bear a resemblance to a sharpened golf tee. They are glued to a pad or thickened area inside the proboscis. They typically are released or break off upon striking the prey. When the proboscis is withdrawn, it is reloaded with another stylet. The animal secretes extra stylets and may have as many as a half dozen in reserve at any one time. Some common genera of Enoplans are *Paranemertes*, *Amphiporus*, *Emplectonema*, and *Micrura*.

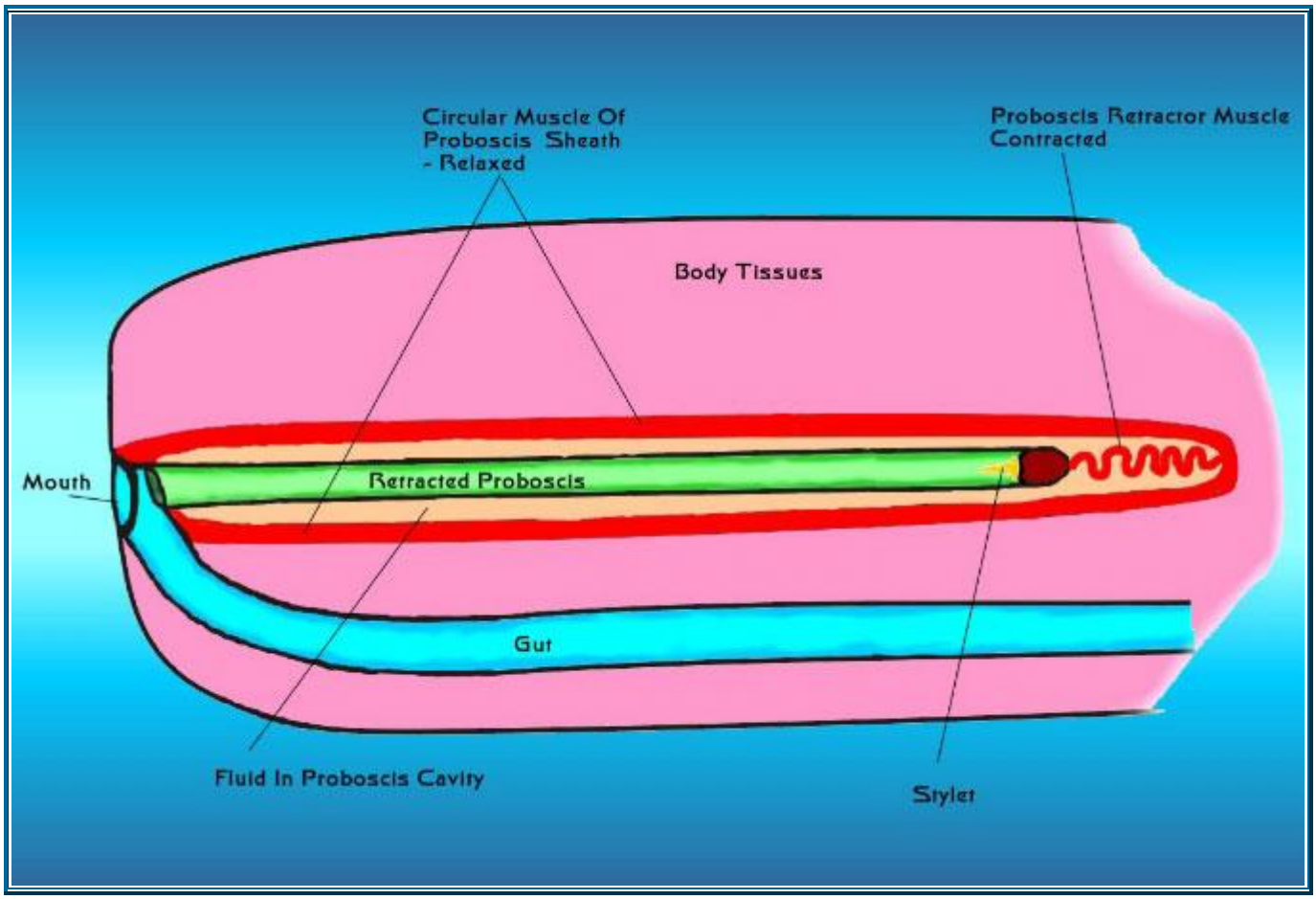


Figure 6. A diagram of the basic structure of the front end of an Enoplan (stinging) nemertean illustrating the retracted proboscis. Note that there is only one open to the outside, and that the proboscis, when everted, will exit through the mouth.

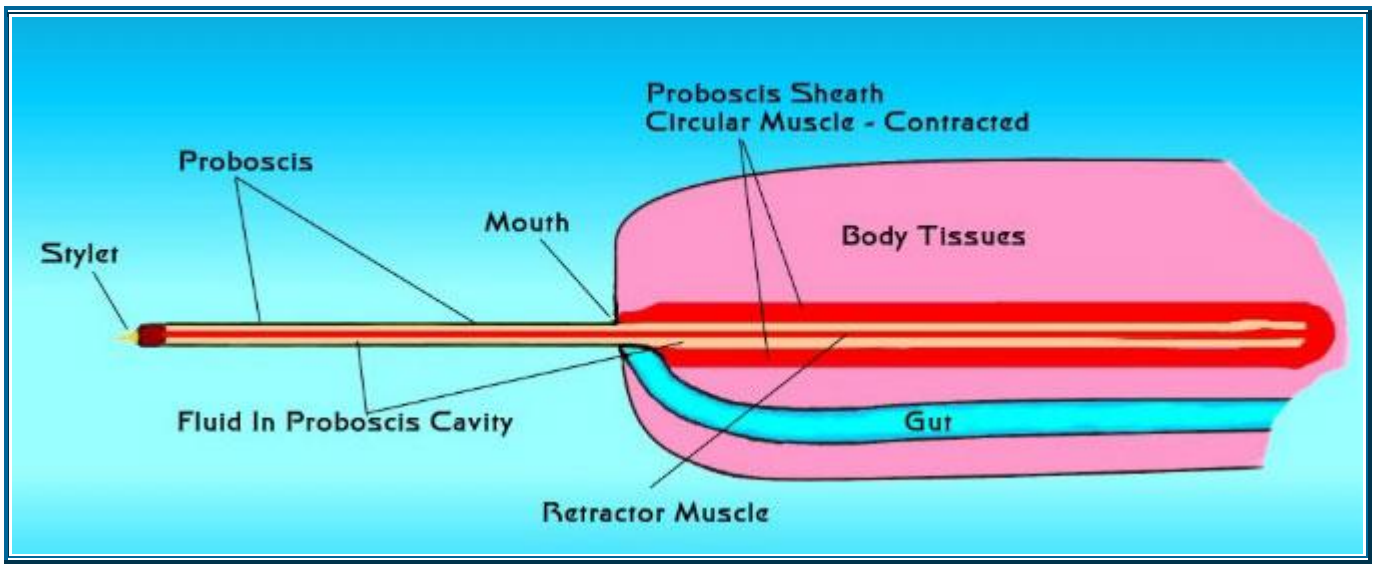


Figure 7. A diagram of the basic structure of the front end of an Enoplan (stinging) nemertean illustrating the everted proboscis. Note that the proboscis can be much larger than shown here, it may in fact be as long as the animal's body.

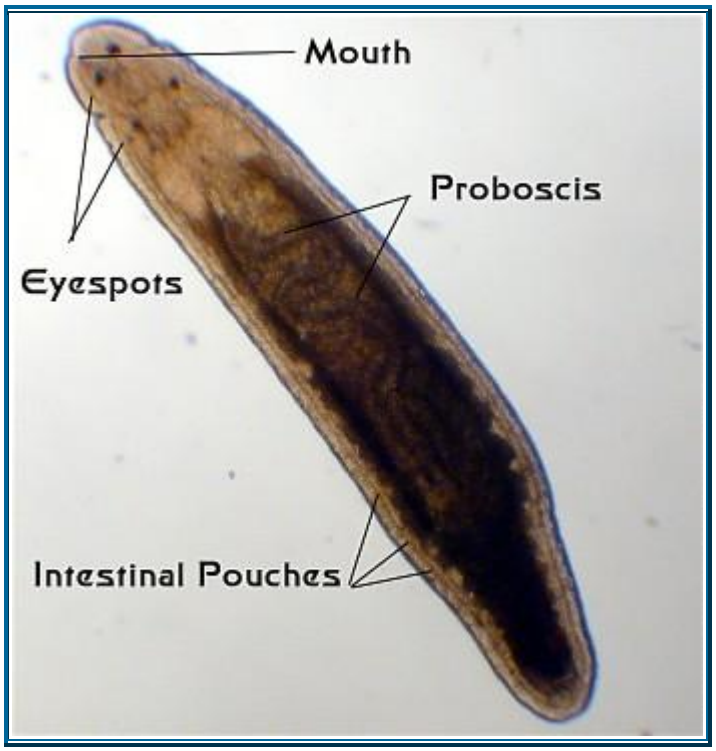


Figure 8. An unidentified enoplan nemertean, about 0.04 inch (1mm) long. This animal has four eyespots. The proboscis is clearly visible above the gut. The intestinal pouches, or caecae, are the site of much of the animal's digestion.

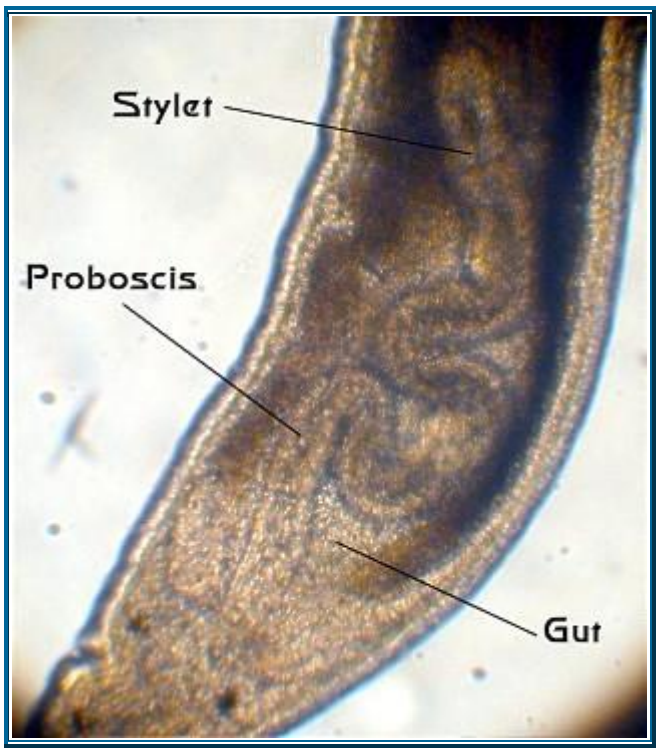


Figure 9. This is the same nemertean as shown in the previous figure. The piercing stylet is visible in the introverted proboscis, as is the gut underlying the proboscis.

Most nemerteans are predatory, but a few are parasites. The diets of relatively few of them have been documented in detail. The prey appear to be primarily polychaete annelids, crustaceans such as barnacles and amphipods, or fish. *Cerebratulus lacteus* from Nova Scotia is odd in that it eats *Mya arenaria*, a rather large clam. Several species of some specialized nemerteans, such as species of *Malacobdella*, are commonly found inside the mantle cavities of large clams. Although it is widely thought that the clam-dwelling nemerteans are parasites, in fact, they eat small crustaceans and worms found in the mantle cavities. They are probably best considered to be beneficial symbionts that clean the mantle cavities of pests.

Some of the truly parasitic forms live on crabs and are egg parasites. On the west coast of North America, *Carcinonemertes* species are found infesting several species of crabs. These are tiny nemerteans that live on the outside of the crab's carapace. They eat the eggs of the crabs; each worm can eat an egg or so a day. An infestation of several dozen worms can effectively eat the entire yearly spawn of the crab. These particular nemerteans can be of immense economic importance, and have been credited with single handedly destroying the economic viability of several Dungeness crab fisheries along the coast.

Aquarium Occurrences and Care

Several different nemerteans have been reported over the last couple of years in my **forum** on Reef Central. They are all moderately sized animals, a few inches long, and they probably hitchhiked into aquaria on live rock. Nemerteans are mostly predatory, and although a few, notably some large **Antarctic forms**, have been seen to be scavengers. It is a pretty safe bet that any turning up in aquaria will be predatory. Some of them seem to be fairly specialized in their diets, ***Paranemertes peregrina*** in the Northeastern Pacific has been well studied and appears to eat mostly one species of polychaete annelid, *Platynereis bicanaliculata*. Others may be less picky in their foods.

I don't think I would consider any of these animals, *a priori*, as a decided risk factor for any aquarium inhabitants. Neither, however, would I consider them as benign. I like nemerteans and consider them very neat creatures, but I would not risk them in my reef aquarium. I would put them in a small dedicated tank. In such a tank, they will do very well if fed properly. I maintained a large (45 feet long) worm in a chilled demonstration aquarium in one of my teaching labs for over six months and it did very well, indeed. At the end of the class year, I released it back into nature where it presumably may still reside.

Nemerteans need good water quality! They produce a lot of mucus and good filtration is a must. The benthic species also need an appropriate substrate. Those animals that enter aquaria as hitchhikers on rocks will benefit from some rockwork in their home. They will generally hide in the rocks when not hunting. Standard reef temperatures and salinity are also necessary. Should you find yourself caring for a nemertean, you are probably on pioneering ground. While a few species have been studied, the biological interactions and natural history of most of them are unknown. The small species may not live lives of very long duration, but the larger ones might well live several years to decades. Many of these are exceptionally colorful and attractive animals so if you find one in your aquarium, don't be in a hurry to dispose of it. It might be well worth the time and expenditure of setting up a small species tank.

If you have any questions about this article, please visit my author **forum** on Reef Central.

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Mything the Point, Part Three: Conclusion

This article represents the last part of a three part series covering the many and widely variant sources of reef fallacies and suppositions. As I mentioned at the end of the last part in the series, the list I have made here is by no means exhaustive, and one could practically continue with such a listing for a very long time, and for a great many words. I fully envision a whole new series of articles as being possible within a relatively short period of time. This is unfortunate, but stems largely from the fact that reef keeping is still a relatively new practice, and there are vast areas yet to be understood more completely.

It is fortunate that as the numbers of aquarists increase, so do the number of significant findings associated expressly with aquariums. Using information based on the biology and ecology of natural communities, physical and chemical canons, and general scientific bases is a strong start. Yet, there are idiosyncrasies and specificities that occur in aquariums that are unlike anything found in nature. As such, more direct, careful, and judicious experimentation will quickly lead to the elucidation of many of the artifacts of closed system aquaria.

Myth 14: Microbubbles are to be avoided.

Many aquarists go to some considerable lengths to baffle sumps and pump flows to prevent small bubbles from being returned into the display tank. It has been suggested that such bubbles represent an irritation to fish, corals and other invertebrates and that they should be avoided. To be honest, I am unsure from where the origin of this perception came. However, it is untrue. Even the name is inaccurate... the prefix "micro" would refer to bubbles too small to see.

The onslaught of bubbles from this oncoming wave should make it apparent that corals and coral reefs exist just fine with the presence of air bubbles in the water.

Small bubbles are very common in tumultuous reef environments, and areas where waves break are often dense with both reef life and small bubbles. In addition, in tanks and on reefs, many bubbles of various sizes, including true "microbubbles" are produced by photosynthesis, and this is especially the case in highly illuminated environments. In my own aquaria, a constant rise of bubbles, especially in the afternoon, are produced by various corals and algae in even some of my less-illuminated systems. Larger bubbles frequently get sucked into pump intakes, and are chopped up to even smaller sizes and distributed throughout the tank. I won't even begin to discuss the massive numbers of bubbles produced by various surge devices. These water motion devices have great benefits in aquaria, and even as anecdotal aquarium observations, I have never seen anything disturbed, irritated, or harmed by the rush of bubbles.

Potential: Relatively harmless. Neither bubbles nor the lack of them in a tank is likely to endanger the health or survival of organisms.

Distribution: A patchy, but common belief.

Myth 15: Concepts about Nitrification, Stocking Orders, and the New Tank

I had owned Nilsen and Fossa's The Modern Coral Reef Aquarium for several years before I noticed one particular photo in that book that is exceptional. It is a nice reef tank, but by no means what most would consider to be a "show winner." However, it is unquestionably a show winner, for it is a reef aquarium that grew solely from live rock. If there is one universal answer to the question, "What does it take to make a successful reef aquarium," the answer is patience.

For those who have not read one of the threads stuck at the top of The Coral Forum, I offer this revised version of that information. A tank begins without populations of anything. Live rock typically forms the initial basis of the biodiversity. Virtually everything is moderated by bacteria and photosynthesis in our tanks. So live rock is the substrate for these microbes and processes, and also has a lot of other life on it. How much depends on a lot of things. Mostly, marine animals and plants don't like to be out of water for a day, much less the many days to sometimes weeks that is common during live rock collection and shipping. So, assuming that existing rock from a tank is not being used, nor the well-treated aquacultured rock, most live rock is either relatively free of anything alive, or has a few stragglers and a whole lot of stuff dying or about to die because it won't survive in aquariums. From the moment it is added to the aquarium, a deficiency has begun that likely worsens over time. Coralline algae, sponges, worms, crustaceans, echinoids, bivalves, algae,

chordates, and all manner of other taxa will begin dying, many of which are within the rock and would never be seen. All this occurs without mentioning the algae, cyanobacteria, and bacteria, most of which is dead and will decompose, or which will die and decompose. Life will return to some degree, as we all have experienced, but not until death and more death have occurred. However, this process is where it all begins.

Bacteria grow really fast, and so they are able to grow to levels that are capable of taking up nitrogen within a typical cycling time of a few weeks to a month (or so) to levels where ammonium and nitrite are not measurable by hobby test kits. Most people assume, wrongfully, that the tank is now "cycled." However, the fact that ammonium and nitrite are no longer easily measured does not in any way imply that the tank is truly cycled, mature, stable, or in any way able to easily support life in the form of new additions. I will discuss this more in the passages below.

If one realizes the doubling time of many bacteria, one would know that within a month, there should exist a tank packed full of bacteria with no room for water. That means something is killing or eating bacteria. It should also be realized that if the tank has decomposition happening at a rate high enough to spike ammonia off the scale of a hobby test kit, there is a lot of food for bacteria that consume this material, and far more than will be present when other things stop dying off and decomposing. So, bacterial growth may have caught up with the level of nitrogen being produced, but things are still dying. An aquarist simply "tests zero" for ammonia because there are enough bacteria present to keep up with the nitrogen being released by the dying organisms. It does not mean things are finished decomposing.

Now, if things are decomposing, they are releasing more than ammonia. Guess what dead sponges release? All of their sequestered toxic metabolites. Guess what else? All their natural antibiotic compounds and these will prevent some beneficial microbes from doing very well. The same occurs with the algae, many other invertebrates, the cyanobacteria, the dinoflagellates, and others. Suffice to say that this death and decomposition is going to take a while to complete.

Through the initial periods, there will be a tank packed with some kinds of bacteria, probably not much of others. Eventually, the massive death slows and stops. Now, what happens to all that biomass of bacteria without a food source? They die. So, another cycle of decomposition begins, and this back and forth process will continue for a while until equilibrium is reached. I say equilibrium, but that is a relative term since reproduction and mortality is a constant process in our tanks, as are "mishaps" and the relative size of the pendulum swing will depend on the reproduction and mortality rates, and biomass of the organisms involved. Still, the new swing of dying bacteria also has antibiotics, toxins, and other substances released when they die. But, the die-off is relatively slow, and is relative to the loss of nutrients, and there is already a huge population present. The result to the aquarist is that they never test positive for significant levels of ammonia. "The water tests fine."

Furthermore, denitrification is a slow process. Yet, all these back and forth swings are happening... every time, they get less and less, but they keep happening. Eventually, they slow and stabilize. What's left? A tank with limited denitrification and a whole lot of other stuff in the water. Who comes to the rescue and thrives? The next fastest growing groups... cyanobacteria, single-celled eukaryotic algae, and other protists. Then, they do their little cycle thing. And then come the turf algae. Turfs will soon get mowed down by all the little amphipods that are suddenly springing up because they have a food source and will reproduce rapidly. Perhaps the aquarist has purchased some snails by now, and maybe a fish. All too often, the fish dies, because while it may not have ammonia to contend with, it has water filled with chemicals we can't and don't test for. Beginning aquarists may also have been too frugal with their purchase of important equipment like lights and pumps, and may not have yet figured out the important alkalinity test, so pH and O_2 are probably

swinging wildly at this point. Tests for phosphate are also usually an afterthought, often purchased only when algal biomass becomes uncontrolled.

No one wants their tank to look like this!

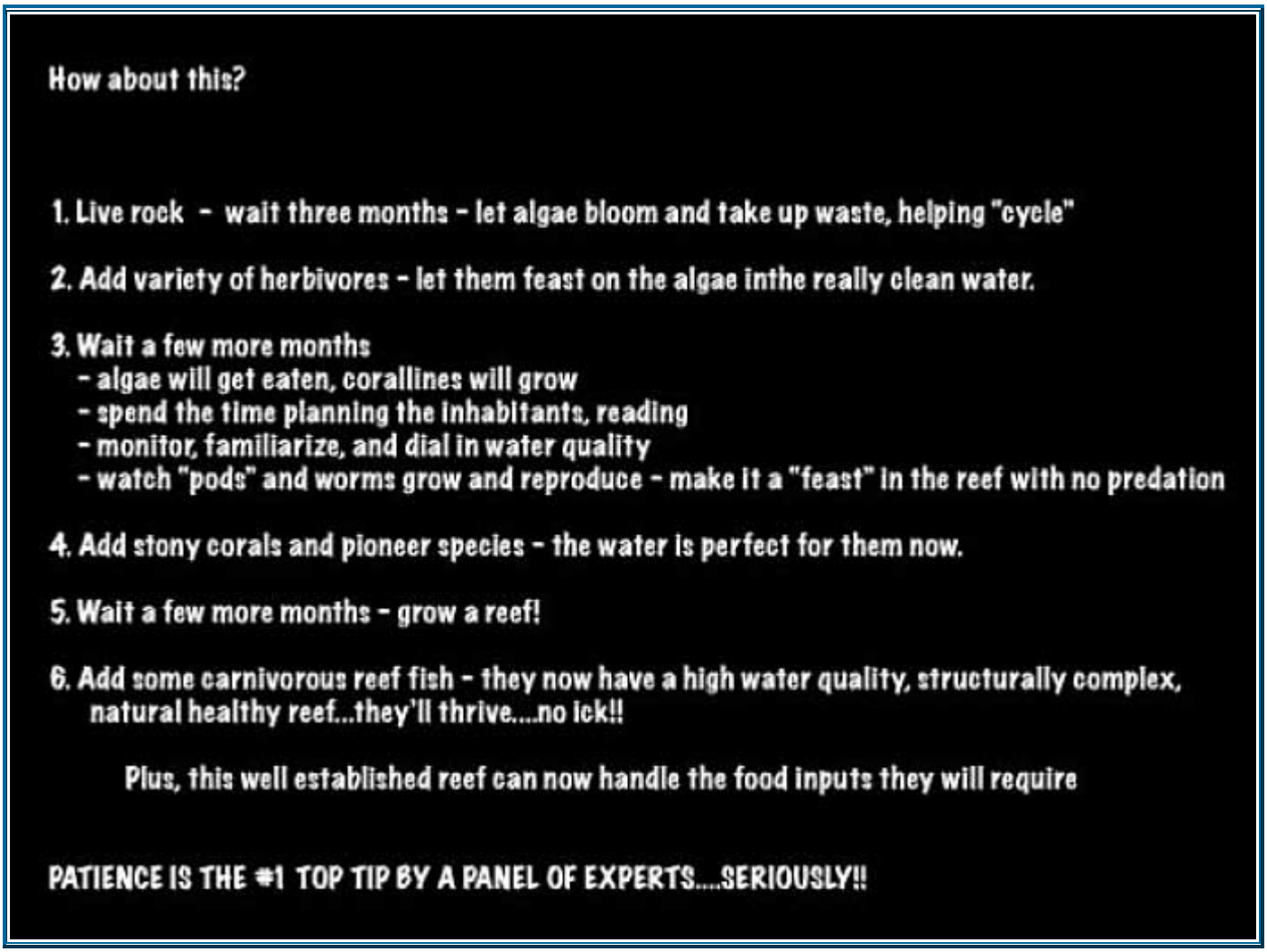
As a few more months pass, the algae successions begin, and eventually there exists an algal biomass that handles nitrogen along with the bacteria, and the aquarium keeper has perhaps stopped adding fish for the time being because they keep dying. Maybe during this time they started to visit internet forums, read books, begin learning more, and get the knack of the tank at least a little bit. They have, unfortunately, probably added a smattering of "fix-it-quick" chemicals (that probably didn't help any, either). Also, there are probably two further scenarios; aquarists that are scared to add corals in their "new tank of death" that would actually help with the photosynthesis and nutrient uptake, or aquarists that have packed in corals (most of which aren't tolerant of the "tank of death" conditions). Equally common are aquarists who stock their tank haphazardly without consideration of whether or not the habitat present is suitable, but that is a topic for another article. What may be relevant, however, is the common pattern of stocking corals according to "hardiness" over time. Initially, soft corals of the family Alcyoniidae (leather corals), corallimorpharians (mushrooms) and zoanthids are the first species to be purchased. The rationale for most is that they plan to stock with easy corals and then "move on to stony corals." The problem with the rationale, seemingly logical though it may be, is that success of these type species may make the tank even more incompatible for the success of stony corals because they are typically superior competitors (usually by secreting waterborne chemicals that inhibit or kill the stony corals or by the capability of overgrowing them).

A host of "fix-it-quick" products exist to help new aquarists through early troubled times.

relatively stable, and the aquarist has probably bought at least a few more powerheads, understands water quality a bit, some corals, coralline algae and other algae are photosynthesizing well, and the tank is becoming "mature." That's usually when fish stop dying and corals start to live and grow.

Ecologically speaking, this is successional population dynamics. Its normal, and it happens when there is a hurricane or a fire or other disturbance. In nature though, there are pioneer species that are eventually replaced by variably persistent "climax" communities. We usually try and stock tanks immediately with climax species and find it doesn't always work. The preceding passages illustrate what good approximations reef aquariums are of mini-ecosystems. Processes and events tend to happen much faster in tanks, but this should be expected given the number of organisms per unit area. Our "climax community" happens in a couple of years rather than a couple of centuries, but it happens nonetheless.

After all the descriptions above, perhaps the "myth" that is the focus of this article has been forgotten. This section actually covers several myths: the myth reflected by the statement "my tank is cycled" or "my rock is cured," and the myth of the statement "my water tests fine." The truth is that the tank is never cycled, the rock is never cured, and water that "tests fine" may be variably fine in terms of one or a few parameters that may or may not be ultimately important for the survival of the creatures we keep in aquaria. As a supplement to this section, I offer some advice (and "advice" is not something I am overly fond of providing because it tends to be limiting to the viewpoint of the person giving it!). I offer the words from a slide I have given in presentations and am frequently requested to print or email after I have shown that slide to a group. The following is how I would suggest new tanks be initiated:


How about this?
1. Live rock - wait three months - let algae bloom and take up waste, helping "cycle"
2. Add variety of herbivores - let them feast on the algae inthe really clean water.
3. Wait a few more months
- algae will get eaten, corallines will grow
- spend the time planning the inhabitants, reading
- monitor, familiarize, and dial in water quality
- watch "pods" and worms grow and reproduce - make it a "feast" in the reef with no predation
4. Add stony corals and pioneer species - the water is perfect for them now.
5. Wait a few more months - grow a reef!
6. Add some carnivorous reef fish - they now have a high water quality, structurally complex, natural healthy reef...they'll thrive....no ick!!
Plus, this well established reef can now handle the food inputs they will require
PATIENCE IS THE #1 TOP TIP BY A PANEL OF EXPERTS....SERIOUSLY!!

the worst, these early misconceptions lead to long-term problems with tanks, have medium-term direct effects, and short-term mortality associated with them. Often, prevention and understanding would alleviate the issues, and surely many aquarists leave the hobby because of the many problems that happen early on with new aquarium set-ups.

Distribution: Nearly universal. Being patient with a new tank is almost an exercise in futility that requires restraint. Generally, only those who have kept reef aquariums prior to establishing a new one are likely to take the steps required to ensure the best development and success of new set-ups (and this is still comparatively rare). Ultimately, the development of a tank by the actions of an aquarist who "goes slow" will far outpace those of aquarists who lack the patience and foresight.

Many years down the road, another condition might occur when the system is too mature; this is sometimes called "old tank syndrome." What happens in this situation is that conditions have become somewhat stagnant, or populations that are present are either limited by some resource or are the only species capable of persisting in the relatively non-fluctuating environment. This happens in nature, too. The well-known example of a forest fire reinvigorating the system is true. Equally true examples occur on coral reefs where the intermediate disturbance hypothesis is an experimentally favored explanation of why coral reefs maintain very high diversity; they are stable, but not too stable; require storms, but not catastrophic ones; need predation, but not a giant blanket of crown of thorns starfish; tolerate mortality, but not mass coral bleaching or the near total loss of key herbivores.

Myth 16: Corals will regrow over dead areas of their skeleton.

This one is only partially a myth. Living coral tissue may indeed grow back over skeleton that has been exposed from partial mortality of the colony. However, there is no real reason to suspect it will, and unless there are small bits of tissue still living inside the apparently dead skeletal corallites, the process is not as it may appear if exposed areas are eventually recovered by living tissue.

Coral skeletons form part of the reef framework. Once they die, for whatever reason, the skeletons are eroded and become encrusted by other life, including other corals. With partial mortality, living parts of a colony have no "attachment" to their old vacant corallites, figuratively or literally. It is not a preferred place for them to live and grow. The coral tissue that remains alive will simply keep growing and calcifying, upwards and outwards. Whether or not it grows outward and recovers its own dead skeleton is mostly a matter of how favorable it is to grow in that direction. Generally, at the rate corals grow, the exposed skeleton will have long been covered with other organisms vying for space before the coral can grow over it. To retake that skeleton means that some sort of competition will be required. In some cases, it may simply be overgrowing coralline algae. But, if it means overgrowing more competitive organisms, the remaining colony may just grow off in other more energetically favorable directions. In fact, this is more than likely what would happen.

Even if the coral does recover its own dead skeleton, the polyps that grow over it will not take up residence in the old corallites. They will create their own new ones on top of the old ones. This type of regrowth can be used as a proxy of environmental events that caused partial mortality to a colony, and cores taken from old colonies usually show a change in the primary axis of growth when the skeletal core is examined in cross section.

As I stated in my first article in this magazine, partial mortality of a colony is nothing to be concerned about, and whether or not it ever becomes recovered with the same coral's tissue is not really a concern so long as the remaining polyps of a colony continues their growth somehow. After all, none of us are really too concerned about the appearance of all the calcium carbonate that lies

underneath the living veneer of tissue, either. Time heals all wounds, even in coral colonies.

Potential: Minimal in terms of the health of the tank and the coral colony.

Distribution: patchy but common statement and belief throughout aquarium circles.

Myth 17: You can never skim a tank too much.

Yes, you can. Far too many works have dealt with various aspects of protein skimming. I still feel there is too little information on exactly what, how much, and how effectively foam fractionation affects various components of the water column of reef aquaria. For the most part, protein skimmers are employed as water quality control devices to maintain low levels of organic and some inorganic materials, notably compounds containing nitrogen and phosphorous commonly linked to degraded water quality not conducive to the growth of many reef species such as corals. Whether or not they are used secondarily for other questionably useful purposes such as elimination of toxins or increasing oxygenation is another matter. My point is that once nutrient levels are low and conducive to a healthy aquarium, and until other secondarily important aspects of protein skimming are experimentally validated and quantified, any skimming over that required to maintain low levels of organic and inorganic pollutants is overskimming. Why? Because if the water is cleared of those things that are detrimental, it is also likely to be equally cleared of things that are beneficial. Given the now well-recognized limitations of providing large amounts of food without a corresponding decrease in water quality, skimming as little as possible while maintaining the aforementioned high water quality is only pragmatic. There is no advantage to a constantly stripped water column in all but a very few specialized situations.

If I were asked what a solution might be, I would propose the following. Use the most efficient skimmer possible and one that is capable of maintaining high water quality when used constantly. Assuming that they do provide some amount of oxygenation, even if minimal, I would then begin shutting off the skimmer during the day for a few hours and measure tank condition visually and through testing for several weeks. If water quality is maintained, I would increase the number of hours the skimmer is off, and wait again, continuing this process until the maximum number of hours is reached where water quality and tank health remains the same without the use of the skimmer. I would also opt for daylight discontinuance since oxygen is less of a problem when photosynthesis is occurring, and since most aquarists tend to feed fish and other products like phytoplankton during the day. This way, residual foods will not be removed for at least several hours. Some aquarists may even find that they can discontinue skimmer usage entirely (I think this likely, especially if activated carbon is employed).

Potential: Minimal to serious. In the best cases, continuous skimming results in relatively healthy tanks that are considered successful by most standards. In the worst cases, organisms perish because of the lack of available foods in the water column. In most cases, the results are a "sterile" looking tank with little alive but corals and coralline algae. Corals tend to appear weakened and, for lack of a more accurate description, not robust.

Distribution: Extremely widespread. There are many who employ alternate means of tank filtration, and these are usually the same people who appreciate the obvious differences in allowing more material to remain in the water column without compromising water quality. Foam fractionation use is both desirable and extremely widely employed, but as with other things should be employed properly and with a judicious purpose.

Myth 18: My aquarium is a reef-crest type tank.

Sorry, but I very much doubt it. There are many reef crests that are occasionally exposed to widely variant conditions that range from onslaughts of rushing water to absolute stillness. But, the typical fringing coastal, atoll, or barrier reef crest is someplace humans don't usually go or can't negotiate. Why? Because of the imminent threat of serious personal injury. It only takes a very small wave breaking over shallow corals to toss a human of considerable weight like a leaf in the breeze. If one snorkels near a reef crest, it is a constant physical negotiation to keep from being smashed onto rocks and coral. A continuous body adjustment as one is lifted up and down and side to side, consisting of dexterous twists and brief sprints, is required to be in this area. Even fish adjust their swimming behavior. As waves approach and cross an area, small fish trying to maintain their position or territory swim as hard as they can in one direction, only to quickly stop as the wave passes. Other fish take shelter in corals and rocks each time a wave passes. While not on the reef crest, nearby stiff-bodied invertebrates strain against the water forces, bent sideways every few seconds. Softer bodied creatures, only existing in more protected nooks alee of wave action are pummeled, and it amazes and fascinates me that they survive the continuous unrelenting barrage of wave action. On the reef crest itself, it is very unlikely soft bodied sessile animals will exist. It is a very stressful, violent, inhospitable and relentlessly tiring place to live.

Many aquarists think of reef crests as being areas where many species of *Acropora* and small polyped corals are found. In fact, only some species are found there and the greatest diversity exists quite a bit deeper. Staghorn corals are not found on most reef crests because they would be shattered. Table corals are not found on reef crests. They would be uprooted. Only the most robust growth forms exist there, and colonies tend to be small. On many reef crests, the force of water and the particles in it are too erosive and abrasive to allow for any soft tissues to exist, and corals are excluded. In such places, coralline algae and perhaps encrusting *Millepora* are providing the cover of the reef crest.

I have never seen a home aquarium where I would feel physically in danger were I able to get inside of it. I have never seen a pump that would toss me around like a leaf. I have never seen any tank anywhere that in anyway resembles a reef crest. Even small crafts with outboard engines have difficulty maintaining a position anywhere near a reef crest, and I suspect no one has an aquarium that would thwart a 40 horsepower Johnson outboard. To provide conditions even like those at five to ten meters depth in an aquarium would still be quite a feat.

Potential: Minimal to serious. In most cases, this myth is just a misconception of the nature of both the reef crest and the tank. It won't do much harm. However, if one perceives their aquarium to be a reasonable facsimile of a reef crest and attempts to maintain animals found on or collected from a reef crest, failure might be the result.

Distribution: Fairly common, especially among non-divers and enthusiasts of small-polyped corals.

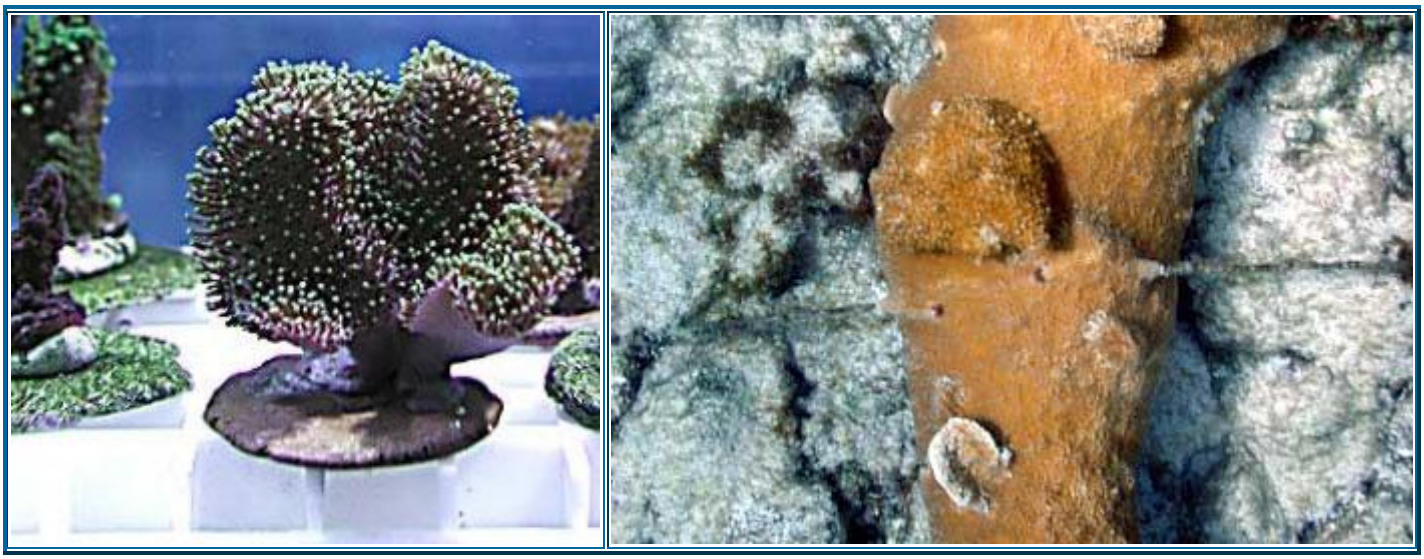
Myth 19: To propagate corals, one should break or cut off a branch or section, and then apply glue or affix the broken fragment to new substrate.

Coral propagation is really quite easy. But, as I have said many times, these are not plants. Perhaps the use of terms like "stalks" and "branches" and "photosynthesis" confer this notion. But, one should not "plant" corals with the healthy parts up and the broken edge in the dirt, as though this was the "root area."

The goal in propagation is rapid attachment with low mortality. Broken tissue is an injury, and injuries are more prone to get infected. Reef substrate is covered in biofilms and other microbes. The substrate also has reduced oxygen and water flow, and is a site where other organisms may

engage in competitive or predatory behaviors. Finally, injured tissue must undergo repair before growth is initiated. The only helpful attribute of the "coral planting" method is that the tissue edges are often sealed by cyanoacrylate (super glue) that minimizes chances of infection. Epoxy putty, however, confers much less of an advantage since the glue is much less adhesive to mucus-covered tissue unless very diligently applied.

Providing the maximal amount of healthy tissue against substrate encourages rapid attachment and reduces the chances of infection and mortality. Placing cut edges in water flow encourages healing and reduces the effects of the detrimental attributes of substrate. Try it. I suspect all the little "pine seedling" propagators out there will soon change their ways.



The photo above left shows the "wrong way" to mount corals. The photo above right shows the right way to mount corals.

Potential: relatively minimal. Corals are tolerant animals, in general, to fragmentation and the majority of fragments even affixed in the wrong way by "planting them" will probably survive. Some that do not survive may have survived if affixed by a different method more conducive to regeneration. The biggest potential detriment is the increase in the time it takes for fragments to reattach and in reduced growth potential.

Distribution: Extremely widespread. Almost everyone, including those who propagate corals "professionally" are mounting corals incorrectly.

Myth 20: The aquarium hobby has little to no impact on reefs.

In some cases this is true, in some cases this is untrue, and in most cases we just don't know what our impact is. But, in some cases the aquarium trade has caused significant declines in targeted species. The solution is to be aware of what wild collected species are common, and which are not, and to always purchase sustainably collected, maricultured, or aquacultured stock when possible. I look forward to covering this topic in much greater detail in a future article.

Potential: Devastating to some species, of minimal concern for others.

Distribution: This is a widespread conception that is unfortunately based largely on supposition and the hope that the statement is actually true.

Summary

This series has been a very incomplete look at some of the more pervasive myths that are part of the

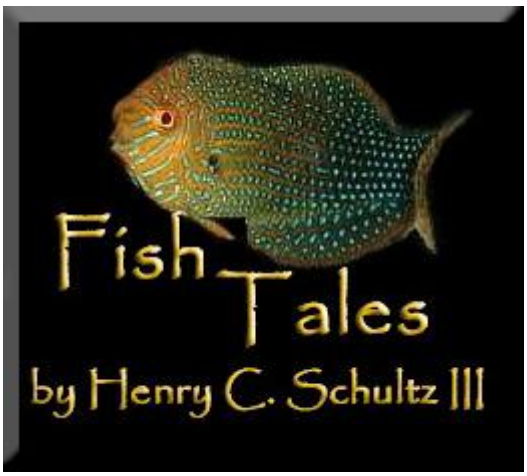
community of people keeping marine and reef aquaria. In the first part of the series, I began with a somewhat lengthy discussion of critical thinking and definitions of terms like "anecdote."

Being skeptical and critical in our assessment of information in this hobby is imperative. The facts are few, the opinions are many. The general level of understanding is low, the data to support our observations scant, and what persists is the all-to-common willingness to support our own shortcomings of knowledge with those spoken and written by those equally or sometimes more in the dark than ourselves.

We must listen more, think more, read more, and speak less. At the very least, we should temper our enthusiasm and excitement by prefacing our supposed truisms with really helpful modifiers; could, should, might, probably, seems to, in my observations, in my opinion, and looks like will more credibly explain the immense number of unknown possibilities that express themselves regularly to us through the windows of our tanks. In time, we might even be able to say assuredly "my water tests fine" and quantify how "my tank never looked better."

Link to **Part One**, **Part Two**

If you have any questions about this article, please visit my author **forum** on Reef Central.



"You May Call Me 'Yasha,' King of the *Stonogobiops*"

Back in 1998 a new species of goby started to appear in the marine aquarium trade with some regularity. It was much different than any goby seen previously, so naturally it garnered attention. Names such as White ray goby or Yasha Hashe goby began to circulate amongst the internet hobbyists and wholesalers alike. In either instance, everyone has been quick to also label it the name of the genus, *Stonogobiops*. For many years this was the most definitive name we could offer outside of the common names our local retailers provided. However, this all changed in 2001 when a pair of scientists awarded the newest member of *Stonogobiops* with a valid species name.(Yoshino and Shimada, 2001). The most observant of goby aficionados may have just needed to read the previous sentence twice. Yes, I did just say 2001. So, why is it as recent as 2003 authors and hobbyists are still referring to Yasha Hashe as *Stonogobiops* sp.? Are they just trying to **make Eric Borneman proud**? Sorry, but we are not discussing *Acropora* sp.; this is a fish. We should be more than capable of referring to the species name during any discussion. So what is my New Year's resolution for 2004? I wish to get hobbyists across the world to stop referring to the Whiteray Shrimp goby as

Stonogobiops sp. and to start calling it *Stonogobiops yasha*.

The highly sought after *Stonogobiops yasha*, thanks to an outgoing personality and fabulous markings, makes a terrific addition to most small, peaceful aquariums. Photos by Henry C. Schultz III (**left**) and ©Manuela Kruppas (**right**).

Meet the Family

The Gobiidae is the largest family of marine fish with over 2,000 members and it is still growing. Most Gobiidae are characterized by a few notable attributes. Other than the few gobies that swim above the substrate, most lack a swim bladder and lateral line. However, gobies have sensory ducts around their heads that make up for the loss of the lateral line (Smith and Knopf, 1997). Another interesting characteristic is the condition of the ventral fins, which in most gobies have joined together and developed small suction cups on the end. Also, every goby is a demersal spawner with most species having both parents acting as guardians over the eggs (Smith and Knopf, 1997). Some gobies will even produce sounds during courtship or territory disputes (**CIBRA**)!

Stonogobiops is considered to be a relatively new genus as it wasn't raised to generic status until Polunin and Lubbock (1977) described *Stonogobiops dracula*. In Hoese and Randall (1982) three additional species were added to the genus, followed by one species in Iwata and Hirata (1994) and finally the last species (for now) in the aforementioned Yoshino and Shimada (2001), which brings the total number of *Stonogobiops* species to six.

- Gobiidae
  - • *Stonogobiops*
    - § *dracula*
    - § *medon*
    - § *nematodes*
    - § *pentafasciata*
    - § *xanthorhinica*
    - § *yasha*

The relatively young age lends some assistance in keeping the genus fairly well organized. However, a shared characteristic belonging to several goby genera has assisted to keep little confusion in this

genus. Unlike most gobies, *Stonogobiops* species have "vomerine teeth." These are teeth that are present on the vomer, a thin bone along the roof of the mouth. Eighteen genera of gobies were said to have vomerine teeth, but in fact the exact number has been found to be considerably less (see below). The species that were determined to not have vomerine teeth in fact had a vomerine that extended into the mouth. This abnormal vomerine extension was likely mistaken for vomerine teeth in their original description (Hoese and Randall, 1982).

Gobies with True Vomerine Teeth	
Bostrychus	*Cryptocentrus**
*Ptereleotris***	*Palatogobius***
Stonogobiops	*Vomerogobius***

***** Not all members of this genus have vomerine teeth.
****** Teeth are weakly attached and easily fall out.

In addition to the above genera, three additional genera have been noted to have vomerine teeth. Unfortunately, I was unable to locate any additional information on these unnamed genera. Therefore, I feel it is important to note the species which were initially reported to have vomerine teeth, but further research has proven they **do not** have vomerine teeth (see below).

Gobies Erroneously Reported To Have Vomerine Teeth	
Istigobius welanderi	*Calamiana magnoris*
Trimma striatus	*Callogobius kuderi*
Lotilla graciliosa	*Macrodontogobius wilburi*
Mangarinus waterousi	*Cryptocentrus caeruleomaculata*
Cryptocentrus strigilliceps	*Mindorogobius lopezi*
Myersina macrostoma	*Istigobius rigilius*
Cryptocentrus cinctus	*Cryptocentrus inexplicatus*
Cryptocentrus obliquus	*Cryptocentrus singapurensis*
Fusigobius corallinus	*Amblyeleotris fasciata*

In addition to the teeth on the vomer, *Stonogobiops* is noted to be one of the few genera of gobies that has a swim bladder. Additionally, it differs from its closest relative, the genus *Cryptocentrus*, by having a different pore pattern and reduction of sensory papillae on the head.

Stonogobiops is one genus of a small group of genera often referred to as "shrimp-gobies" or "watchman gobies." This is because these fish act as guardians over shrimp of the genus *Alpheus*. This symbiotic relationship will be discussed in detail below.

Genera of Gobies Acting as "Watchman"	
Amblyeleotris	*Cryptocentrus*
Cryptocentoides	*Ctenogobiops*
Flabellogobius	*Gobionellus*
Lotilia	*Mahidolia*
Myersina	*Nes*
Psilogobius	*Smilogobius*
Stonogobiops	*Vanderhorstia*

In the Wild

Stonogobiops species are represented in both the Indian and Pacific Oceans. However, the geographical distribution of each species is fairly limited. The most commonly occurring species, *S. nematodes*, is only common around the Philippine Island region. *Stonogobiops dracula* is the only member from the Indian Ocean, more specifically the Maldives and Seychelles. *Stonogobiops xanthorhinica* has the widest distribution stretching from Japan to the Northern coast of Australia. *Stonogobiops medon* maintains the eastern-most distribution, known only from the Marquesas Island area. It is not unusual for members of *Stonogobiops* to associate nearby other members of the watchman clan. For instance, *S. dracula* has been noted to live near members of the genus *Amblyeleotris*.

Stonogobiops nematodes is the most common of the *Stonogobiops* to make it into the marine aquarium trade. Photos courtesy of Greg Rothschild (**top left**), Scott Chevalier (**top right**) and Philippe Goudket (**left**).

Most members of this genus are commonly found ranging from 60 to 100 feet. However, *S. xanthorhinica* can be found as shallow as 20 feet and as deep as 160 feet. At these depths individuals of *Stonogobiops* species will seek out protected rubble zones edging areas of white sand. Again, unlike most gobies, they utilize their swim bladder by hovering merely an inch or two above the substrate and only two to four inches outside of their burrow.

We should be as lucky as these fish; they never have to maintain or clean their home. Instead, they partake in a unique symbiotic relationship referred to as "mutualism" along with snapping shrimp,

often called pistol shrimp, from the genus *Alpheus*. The term mutualism is derived from both members of the symbiotic relationship having something to gain from the other member. In this instance, the goby, unable to dig its own burrow, lives in the elaborate tunnels constructed by the shrimp. It will utilize these burrows each night when it retires for the evening or anytime danger is present in the nearby vicinity. The shrimp, being nearly blind, is an easy target of predators when it must exit its burrow to remove sand or mud from the burrow. To repay the shrimp for use of the burrow, the goby acts as the guardian of the burrow and warns the shrimp anytime danger approaches. This relationship can begin shortly after the goby settles from planktonic life, which occurs at roughly half an inch in length. An interesting video of the relationship can be seen **here**.

As may be seen in the above video, wormfish from the genus ***Ptereleotris*** are often found as unwelcomed, yet ignored, guests sharing the burrow with the goby and shrimp. Photo courtesy of Jun Harada.

Burrows usually measure up to one inch in diameter, may reach up to six inches of depth beneath the surface, and can stretch for up to four or more feet. *Stonogobiops* are always found as male/female pairs, so there is usually a pair of gobies and often a pair of pistol shrimp living within this cave. In most instances only one entrance/exit is extensively used; however, the constant shifting and settling of the upper layers of sediment requires regular maintenance by the shrimp. It is not unusual for additional entrances/exits to be in either the beginning phases of construction or slowly becoming sealed off over time.

Stonogobiops nematodes is seen here in the wild performing his watchman 'duties' while the shrimp takes care of some housekeeping 'duties' for their burrow. Photo courtesy of Jun Harada.

Every time the shrimp needs to push sand and debris out of the burrow, or to search for the detrital

material it will consume, it makes physical contact with the guardian goby. As can be seen in several of the photos in this article (**here** and **here**), the shrimp will use their antennae and touch the skin of the goby. If all is well, the shrimp will continue pushing sand out of the burrow and pile it just outside the entrance. However, if danger approaches, the goby will begin fluttering its caudal fin, thereby warning the shrimp (Preston, 1978; Karplus, 1979). If the shrimp was attempting to remove sand from the burrow or attempting to forage the nearby vicinity for a meal, it will now wait just inside the burrow until the danger is no longer present. If the shrimp is outside of the burrow at this time, it quickly retreats within the burrow. When the threat of danger escalates, the fish is known to position itself such that its tail is blocking the entrance to the burrow. Under maximum threat, the fish will quickly spin around and dart head first into the burrow. Of course, the shrimp is first to enter the burrow if both the shrimp and fish were outside of the burrow at the time the threat was noticed. For both the shrimp and goby to bolt into the burrow takes less than several tenths of a second.

The shrimp will collapse the entrance each night after all the occupants are inside. This serves as protection from animals that are able to slither into the burrow and capture their prey, such as *Myrichthys maculosus*, the spotted snake eel. Every morning the goby will burst through the collapsed entrance and the shrimp will begin the arduous task of rebuilding the entrance for the following day. Once all the maintenance duties are completed, the shrimp will begin foraging for food and feeding.

There are additional benefits to the goby in this relationship. The female goby uses the burrow as a nesting place for her eggs. Because of this, unfortunately, little is known about the mating ritual of this fish species. Lastly, the shrimp has also been noted to use the smaller of its two claws in actions similar to cleaning as it works over the goby's dorsal fin and caudal fin, possibly cleaning the fish of parasites (Karplus et al, 1972).

The goby always takes its food from the water column. While the fish hovers outside the burrow it is on constant watch for not only predators, but also prey. Prey items typically consist of most anything fitting under the classification of zooplankton. The goby will dart up to one or two feet from the burrow in an attempt to capture prey, always quick to return back to the burrow's entrance immediately after capturing the food item.

There are no readily apparent external differences hobbyists can use to differentiate between sexes. In some instances, pairs have been collected from the wild where the male is the larger member, while in other instances it is the female that is the largest. There have been reports (Baensch, 1994) of using the dorsal spine as a means to indicate the sex of the animal, but after reviewing the research data for this species, that would seem a highly unreliable characteristic. For all intents and purposes, there is no way a hobbyist can tell the difference between male and female *Stonogobiops* while the animal is still alive.

In the Home Aquarium

Stonogobiops species are relatively easy to care for provided their few requirements are met. Obviously of first thought is their relationship with the shrimp. Hobbyists love these relationships, and this one is no different. The good news is that this is a relationship which can be enjoyed in the home aquarium. Sadly, the bad news is that the symbiotic pistol shrimp rarely gets shipped in with the gobies, forcing hobbyists to find one on their own. The shrimp are considerably more difficult to capture and hence usually do not accompany their finned friends. Luckily, the gobies will do just fine in the home aquarium without their shrimp companion. Both the gobies and the shrimp can be very particular about whom they enter into a relationship with, however, so it may be best to avoid trying to pair up the two if they are acquired separately. Oftentimes, gobies will only pair up with one

particular species of pistol shrimp, usually, but not always, *Alpheus randalli* (Hoese and Randall, 1982), as seen in the three photos **below**. Also, because the goby rarely leaves its burrow by more than one or two feet and the shrimp is most often tucked deeply into the burrow, the two are not likely to locate each other if introduced separately to the aquarium. So, try to acquire the goby and the shrimp at the same time as a pair if you hope to witness this fascinating relationship.

Several fantastic photos of the reclusive *Alpheus randalli.* This beautiful

shrimp is the preferred symbiotic partner of most *Stonogobiops.* Photos courtesy of Scott Chevalier (**bottom two**), and Manuela Kruppas ©(**top**).

The best setting for a *Stonogobiops* and their shrimp companion would include a mixed rubble substrate combined with a traditional deep sand bed. The four-inch or deeper sand will afford the shrimp an opportunity to dig and create tunnels as it would naturally in the wild and the rubble will help provide some stabilty for the tunnels. To assist with acclimation it may behoove the hobbyist to bury a piece of PVC underneath the sandbed and utilize a 45 degree bend that breaks the surface of the sand. Place the shrimp in a clear plastic specimen container and keep the open top covered so the shrimp cannot swim out. A large fish net works well for this. Place the container over the open PVC pipe and flip the container upside down such that the open end of the container is now lying down in the sand. Remove the net from the underside and weigh down the container if needed. Within a minute or two the shrimp should find the open end of the PVC and quickly disappear down inside. Once this has occurred, repeat the process with the shrimp-goby. Acclimating using this procedure will ensure the goby and shrimp locate each other, and will give them a head start at building their burrow in the "prime real estate" chosen by the aquarist. Naturally, finding a burrow immediately will also reduce the stress involved with being moved into a new aquarium. If the goby is acquired without the symbiotic partner, it may still be best to utilize the PVC pipe idea; however, a deep sand bed is not important to the captive care of the goby. The deep sand bed is only useful to the maintenance of the pistol shrimp. If PVC is not used or not taken up by the fish or shrimp, a traditional sand bed doesn't really work well. The sands collapse too easily, and the presence of some small rubble or gravel like crushed coral or live rock chips will help reinforce the walls.

Acclimation to aquarium life is a slow battle for this goby. It may take a month or more before the aquarist can expect to see the goby with any regularity. Naturally, with a small, delicate goby such as this, one of the biggest factors in successful acclimation and maintenance is limiting its tank mates. Fast swimming or aggressive tank mates will all but eliminate any chance at success. Aggressive tank mates will obviously keep this goby tucked inside its preferred bolt hole, while fast swimming fishes will undoubtedly do the same. Unfortunately, these fish are also known to be jumpers when frightened, yet another reason to keep the fish load more passive. Aggressive feeders, such as surgeonfish or many of the wrasses, will make it difficult to get enough of the proper foods within striking range of the goby. If the plan is to maintain both the shrimp and goby as a pair, a small, possibly 10 to 20 gallon species dedicated aquarium would be ideal. In this situation the hobbyist is nearly guaranteed an uninterrupted viewing experience of the unique mutuality behavior. If the aquarist is only looking to maintain the fish and not the shrimp, then a larger aquarium with a more diverse community will also work. The ideal mix would include other small dither fish such as Wormfish from the genus *Nemateleotris* or the slightly larger and more active wrasses such as *Macropharyngodon* or *Paracheilinus*.

Compatibility chart for *Stonogobiops*:

Fish	Will Co-Exist	May Co-Exist	Will Not Co-Exist	Notes
Angels, Dwarf		X		A larger aquarium will contribute to greater success.
Angels, Large			X	Large physical size and aggressive feeding nature.
Anthias	X			Provided the aquarium is large enough for Anthias and direct feeding to the goby is administered.

Assessors	X			Excellent choice.
Basses			X	May consume *Stonogobiops* species.
Batfish			X	Large size and aggressive feeding habits.
Blennies		X		Most blennies should do well; larger ones may harass smaller gobies.
Boxfishes		X		The smaller members of the genus are the best option.
Butterflies	X			Excellent choice.
Cardinals	X			Excellent choice.
Catfish			X	May consume *Stonogobiops* species.
Comet		X		Small individuals will do well. Adults may attempt to consume the goby.
Cowfish		X		The smaller members of the genus are the best option.
Damsels		X		Most damsels can be incredibly abusive to tank mates.
Dottybacks			X	Most dottybacks will hunt and kill small gobies - *Pseudochromis fridmani* and *P. springeri* are possible exceptions.
Dragonets	X			Excellent choice.
Drums	X			Excellent choice.
Eels			X	May consume *Stonogobiops* species.
Filefish	X			Excellent choice.
Frogfish			X	May consume *Stonogobiops* species.
Goatfish			X	May consume *Stonogobiops* species.
Gobies	X			Excellent choice.
Grammas	X			Excellent choice, *Gramma* added after goby.
Groupers			X	May consume *Stonogobiops* species.
Hamlets			X	May consume *Stonogobiops* species.
Hawkfish			X	May consume *Stonogobiops* species.
Jawfish	X			The typical Yellowhead or Blue-Spotted is an excellent choice.
Lionfish			X	May consume *Stonogobiops* species.
Parrotfish			X	Overall size and aggressive swimming nature.
Pineapple Fish	X			Excellent choice.
Pipefish	X			Excellent choice.
Puffers			X	May harass smaller gobies.
Rabbitfish		X		Should be OK provided the aquarium is large enough for the rabbitfish and enough food reaches the goby.
Sand Perches			X	Larger individuals may harass or consume *Stonogobiops* species.
Scorpionfish			X	May consume *Stonogobiops* species.
Seahorses	X			Excellent choice.
Snappers			X	May consume *Stonogobiops* species.
Soapfishes			X	May consume *Stonogobiops* species.
Soldierfish			X	May consume *Stonogobiops* species.
Spinecheeks		X		Adult size may be intimidating.

Squirrelfish			X	May consume *Stonogobiops* species.
Surgeonfish		X		Aggressive feeding and swimming habits will likely require direct feeding to the goby.
Sweetlips			X	May consume *Stonogobiops* species.
Tilefish	X			Excellent choice.
Toadfish			X	May consume *Stonogobiops* species.
Triggerfish			X	May consume *Stonogobiops* species.
Waspfish			X	May consume *Stonogobiops* species.
Wrasses		X		Many wrasses are best avoided. The most peaceful ones will be good choices.

Note: *While many of the fish listed are good tank mates for* Stonogobiops *species, one should research each fish individually before adding it to the aquarium. Some of the fish listed above are better left in the ocean or for advanced aquarists.*

Predatory invertebrates such as brittle starfish from the genus ***Ophiarachna*** should also be avoided. Small gobies such as *Stonogobiops* are an easy meal for these aggressive predators. Likewise, anemones such as ***Stichodactyla*** species should be avoided. All too often fish will fall victim to these anemones.

Providing proper food is usually an easy obstacle to overcome once the goby begins to appear in the aquarium. Because they feed from the water column, they will likely snap at anything that floats past. The first *Stonogobiops yasha* I owned ate flake food in the retailer's 6" x 6" holding tank. Since they are not picky eaters, it should be easy to offer a varied diet. As they are zooplankton eaters, a diet rich in enriched brine shrimp or *Mysis* species shrimp is a good start, as is the aforementioned flake food or my personal favorite, fish roe. Most any food geared towards small carnivores will likely be accepted and appreciated. If the fish is in an aquarium with aggressive feeders, it may become necessary to directly feed the fish after placing food for the rest of the inhabitants at the far opposite end of the aquarium. Depending on tank mates, this may be a temporary exercise to ease acclimation or it may become a daily chore.

Meet the Species

By far the most popular *Stonogobiops* that makes its way into the aquarium trade is *S. nematodes*, the Highfin or Blackray Shrimp Goby. The word nematode is taken from the Greek language meaning "thread-like" or "filamentous," obviously referring to the first dorsal spine. Like all the rest of the genus, it remains a diminutive two inches of total length. This goby, always found in pairs, is also noted to associate only with *Alpheus randalli* in the wild.

It is difficult to assess what species of *Stonogobiops* this is. This photo could easily be *S. xanthorhinica*, which differs only from *S. nematodes* with the short first dorsal spine. However, juvenile individuals of *S. medon* also have this same coloration. It isn't until *S. medon* ages into adulthood that it losses the black diagonal stripes. Photo courtesy of Jun Harada.

Stonogobiops pentafasciata is rarely encountered in the marine aquarium trade. Presumably this is because of its limited ditribution around regular collection facilities. Photos courtesy of Jun Harada.

A near exact match to *Stonogobiops nematodes* is *S. xanthorhinica*, or the Yellowfaced Shrimp Goby. Its common name is directly taken from the Greek meaning of *xanthorhinica*. "Xanthos" means yellow and "rhinos" refers to the snout. This goby, also only seen in pairs, relates with the shrimp *Alpheus bellulus*.

A beautiful specimen of *Stonogobiops yasha*, pictured here in the wild. Photos courtesy of Jun Harada.

The most sought after *Stonogobiops* also happens to be the focus of this column. The Whiteray or Yasha Hashe Goby that is commonly referred to as scientifically un-described is actually named *Stonogobiops yasha*. This species is most often found in pairs, but not always. It is, however, always found with the shrimp *Alpheus randalli*.

Conclusion

It seems hobbyists are always looking for the next new thing to grasp their interest. Symbiotic relationships are certainly one of those new elements. However, most aquarists tend to gravitate towards the clownfish-anemone relationship, which is more than a unique relationship itself. But for some hobbyists the clownfish is just too common to satisfy the desire for something novel. For those individuals the goby-shrimp relationship might just satisfy that hunger.

If you have any questions about this article, please visit my author **forum** on Reef Central.

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The Measure of Success

I am always amazed by the number of new aquarists I see on the message board looking for "the secret to having a successful system." I've been in the reef-keeping hobby for almost five years and I consider myself to be reasonably successful. However, while I was at the Marine Aquarium Conference of North America last September in Louisville, I was reminded once again that there is no one "secret to success." Even the term "success" depends to a large extent on the yardstick by which the aquarist is using to measure it.

I met and talked at length with many aquarists at the conference. One of the guys I met was typical of what I call a "water quality aquarist." His idea of success is maintaining the pristine water quality found over a natural reef crest (at least in terms of what can actually be accurately measured or even measured at all!). Any measurable amount of anything in his water except hydrogen and oxygen is unacceptable. As such, he uses heavy skimming, UV sterilization, ozone injection and constant water testing. (Interestingly, though, he spent very little time talking about the animals living in his system). When he asked me about my tank, I sheepishly admitted that I tolerated a small amount of nitrate, encouraged the growth of microorganisms by use of a deep sand bed, and didn't even own half the test kits that he did. I'm sure that in his opinion, my tank is anything but

successful.

Another group of aquarists measure their success by the color and phenomenal growth rates of their stony corals. I think of these folks as the "lighting aquarists." They know the color temperature and output of every bulb on the market. They are experts on reflectors and spectrum distribution and use this knowledge to maximize the growth rates and colors of their corals. I talked to one of these folks and was forced to admit that I would prefer it if my *Montipora* and *Acropora* wouldn't grow quite so fast, as it was difficult to provide them sufficient space. I asked if he could give me recommendations on slow-growth corals. (Funny, but he suddenly remembered an urgent matter requiring his immediate attention and had to excuse himself). So, if I measured the success of my tank in terms of coral growth rates, I would have to give myself an average rating.

Then, there are those I think of as the "life history aquarists," whose measure of success is mimicking the animals' natural life processes in the aquarium; in other words: reproduction... preferably sexual reproduction. These are the aquarists who install "moon lights" and use computer controllers to simulate annual cycles by day length and temperature. I know from personal experience that having a coral spawn in the aquarium is an exciting and fascinating experience. That is, until after the big event when I'm left with an emergency fifty percent water change on a 220 gallon tank. Speaking to one of the life history aquarists, I had to admit that although I had purchased a "moon light" and my tank controller could be programmed to simulate an annual lighting and temperature cycle, I had decided against it. This decision was reached after my clams spawned for the second time in two years, followed two days later by the spawning of an *E. quadricolor* anemone the size of a dinner plate. As much as I realize that sexual reproduction of these animals in captivity is crucial to the continued success of our hobby, the blessed event occurring in my 220 gallon closed system is just too much stress for this reef keeper. My corals grow and reproduce asexually, but alas, I'm not breaking any new ground on the sexual reproduction of reef animals in captivity. Again, if sexual reproduction is the measure of success, my tank falls short.

Next we come to the pioneers of reef keeping, a group I call the "difficult-to-keep-species aquarists." They are determined to master such species as *Goniopora*. These folks, just like the "life history aquarists," are crucial to the hobby. It wasn't too long ago that *Acropora* couldn't be kept alive in an aquarium. I have no doubt that one day, *Goniopora* will thrive in an aquarium the same way *Acropora* do now. But, for my money, I stick to coral species that are content to live comfortably in the environment I can provide right now. If I have more than one failure with a species of coral, I just don't buy any more. So, as a pioneer, I guess I fail.

Finally, there are the "techno-aquarists." These are the inventors of the hobby. A successful system, in their opinion, is one that practically runs itself. They are always looking for, or creating, new gadgets to run their aquariums. (The people in this group can get so focused on the gadgets that they don't notice subtle behavioral changes in their animals that could signal trouble.) While I do use a computer controller to run my lights and pumps, and an automatic top-off to replace evaporation, I haven't really gotten into all the devices available to

simplify my aquarium maintenance. While I do enjoy tinkering with my equipment occasionally, I'm not likely to be the inventor of the next generation surge device or a better, do-it-yourself skimmer. So, as contributions to the ease of aquarium maintenance go, I fail again.

So, here I am... a relative failure at water quality, coral growth, sexual reproduction, difficult-to-keep species and aquarium technology. You would think I would be forced to change my opinion of my own success. But, fortunately, I have my own yardstick. I am a "maximum diversity and knowledge aquarist." I measure my success by the number of different species of critters living in my tank and how much I know about them. My theories of reef keeping are: "Fill as many niches as possible, thereby creating as stable a system as possible" and "The more I know about the animals I keep, the better my chances of keeping them healthy." My animals grow and reproduce (even without my encouragement) and I'm continually finding new critters in my tank and refugium.

Success, therefore, is a matter of opinion. As long as your animals are healthy and you derive enjoyment from your efforts, you have obtained a certain level of success. The only group I consider utter failures are those who refuse to spend the time and energy to educate themselves on the animals they are keeping. Their ignorance costs the lives of reef species and contributes to the degradation of the natural ecosystems. Fortunately, many of these folks leave the hobby either from frustration or the financial burden of replacing dead animals. As an aquarist, the more education you have, the easier it is for you to select the yardstick with which you will measure your success; and, in the end, the more successful you will be.

If you have any questions about this article, please visit my author **forum** on Reef Central.

CORAL REEF SCIENCE: DEVELOPMENT HIGHLIGHTS

ERIC BORNEMAN

This month, I cover several articles on global coral reef decline...

Hughes, T. P., Baird, A. H., Bellwood, D. R., Card, M., Connolly, S. R., Folke, C., Grosberg, R., Hoegh-Guldberg, O., Jackson, J. B. C., Kleypas, J., Lough, J. M., Marshall, P., Nyström, M., Palumbi, S. R., Pandolfi, J. M., Rosen, B., Roughgarden, J. 2003. Climate change,

human impacts, and the resilience of coral reefs. Science. 301 (5635), p.929, 5p, 3 graphs, 2 maps, 1c.

Abstract:

The diversity, frequency, and scale of human impacts on coral reefs are increasing to the extent that reefs are threatened globally. Projected increases in carbon dioxide and temperature over the next 50 years exceed the conditions under which coral reefs have flourished over the past half-million years. However, reefs will change rather than disappear entirely, with some species already showing far greater tolerance to climate change and coral bleaching than others. International integration of management strategies that support reef resilience need to be vigorously implemented, and complemented by strong policy decisions to reduce the rate of global warming.

Pandolfi, John M., Bradbury, Roger H., Sala, Enric, Hughes, Terence P., Bjorndal, Karen A., Cooke, Richard C., McArdle, Deborah, McClenachan, Loren, Newman, Marah J. H., Paredes, Gustavo, Warner, Robert R., Jackson, Jeremy B. C. 2003. Global Trajectories of the Long-Term Decline of Coral Reef Ecosystems. Science 301 (5635), p. 955, 4p, 1 chart, 3 graphs.

Abstract:

Degradation of coral reef ecosystems began centuries ago, but there is no global summary of the magnitude of change. We compiled records, extending back thousands of years, of the status and trends of seven major guilds of carnivores, herbivores, and architectural species from 14 regions. Large animals declined before small animals and architectural species, and Atlantic reefs declined before reefs in the Red Sea and Australia, but the trajectories of decline were markedly similar worldwide. All reefs were substantially degraded long before outbreaks of coral disease and bleaching. Regardless of these new threats, reefs will not survive without immediate protection from human exploitation over large spatial scales.

Gardener, Toby A., Isabelle M Cote, Jennifer A. Gill, Alastair Grant, Andrew R. Watkinson. Long-Term Region-Wide Declines in Caribbean Corals. 2003. Science 301 (5635), p958, 3p, 3 graphs, 1 map.

Abstract:

We report a massive region-wide decline of corals across the entire Caribbean basin, with the average hard coral cover on reefs being reduced by 80%, from about 50% to 10% cover, in three decades. Our meta-analysis shows that patterns of change in coral cover are variable across time periods but largely consistent across subregions, suggesting that local causes have operated with some degree of synchrony on a region-wide scale. Although the rate of coral loss has slowed in the past decade compared to the 1980s, significant declines are persisting. The ability of Caribbean coral reefs to cope with future local and global environmental change may be irretrievably compromised.

Comments:

In this issue of Science, there appeared numerous articles on the decline of coral reefs throughout the world. For those of us working in the field, those who keep abreast of such developments, and those who have spent some time on coral reefs, this is really nothing all that new. However, the data shown here, the scope of the articles and research involved, and the huge author list make quite a statement. More than anything, it shows the nearly unanimous feeling of researchers that our coral reefs have been declining, are continuing to decline rapidly, and are in desperate need of conservation. Let's think about this carefully on our next visit to the fish store. I urge everyone to consider their collections carefully and make sure that whether they cost a few dollars or a few hundred that each one is provided with care that ensures it survival. Moreover, efforts by aquarists to contribute to conservation based programs and efforts are urgently needed. It's our responsibility to care for each species exploited by us for the hobby.

INVERTEBRATE TIDBITS

RONALD L. SHIMEK, PH. D.

This month, I will discuss an interesting article on peppermint shrimp...

Baldwin, A. P. and R. T. Bauer, 2003. Growth, survivorship, life-span, and sex change in the hermaphroditic shrimp *Lysmata wurdemanni* (Decapoda: Caridea: Hippolytidae). Marine Biology (2003) 143: 157-166.

Abstract:

Lysmata wurdemanni (Gibbes) is a protandric simultaneous hermaphrodite. All individuals first mature as a male-phase individual (MP) and then later change to a female-phase individual (FP) that spawns and broods embryos but can also mate as a male. A Gulf of Mexico population was sampled monthly for 1 year and bimonthly the next. Estimates of basic population parameters were obtained from cohort analysis to reveal possible factors explaining the unusual sexual biology of *L. wurdemanni* as well as the broad variation in the size (age) of change from MP to FP. Growth rates of individuals from cohorts varied from 4-7 mm carapace length per year. Growth of small MPs in the laboratory was somewhat faster but concordant with growth rates estimated from field samples. The period from recruitment to >50% sex change in cohorts varied from 3 months to 1 year. In the laboratory, the size and interval to sex change was similar to that of the most rapidly changing cohort observed. Survivorship of cohorts was high until later in life; life-span was estimated to be 12-18 months. Rates of sex change were highest from late winter through spring, in time for the spring-summer breeding season. The size and age of sex change in cohorts were related to the season of recruitment. MPs recruited from late winter to mid-spring rapidly changed to FPs at a relatively small size. A majority of MPs recruited in the summer and autumn did not change to FPs until the following late winter to spring, and they did so at a larger size. Rates of sex change were not correlated with the sexual composition of

the population. We conclude that seasonal factors related to female breeding greatly influence sex change in *L. wurdemanni*. We found no evidence to support demographically influenced and socially mediated environmental sex determination, which has been suggested for *L. wurdemanni* and other sex-changing caridean shrimps.

Comments:

This article discusses everything you wanted to know about the growth and sexual habits of the peppermint shrimp, but were afraid to ask. Some of the interesting points are that the maximum life expectancy in the studied Gulf of Mexico population was only about a year and a half, and that the carapace (the "shell" over the body of the shrimp) increases in length about 4 to 7 mm per year. These shrimp enter the population by metamorphosing from a planktonic larva. Immediately after recruitment they are males. Later, after a period that varied from three months to about a year, they change into a hermaphroditic animal.

If you have any questions about this article or suggestions for future topics, please visit the respective author's forum on Reef Central (**Eric Borneman's** or **Ronald L. Shimek's**).

Top Ten Sales Pitches from the LFS...

10) Just dose this and all your problems will go away.
jetor of San Diego, California

9) Mandarins and small tangs can be kept in a 10 gallon tank, no problem.
Nagel of Hopatcong, NJ

8) Don't worry, this fish is completely reef safe.
Carlyle of Canon City, CO

7) Honestly, the more fish you put in your tank, the happier they'll be.
cryosphere of BC, Canada

6) Well... He's not THAT poisonous!
driver756 of Chattanooga, TN

5) Triggerfish get along great with all types of fish and corals.
MPA of the east coast of Florida

4) Trust me...
Creeper of Chester Springs, PA

3) That's an albino anemone, they're very rare in the ocean.
Agu of Venice, the one in Florida

2) Impossible to keep?! Who told you that? I've had one at home for over a month and it's doing great.
lllosingit of Des Moines Iowa

1) All dead corals, 50% off!
Jamesurq of Greensboro, NC

Reefkeeping's next Top Ten for February: **Top Ten Signs That You Have Too Many Tanks...** Our thanks go out to phuzzy3d for suggesting the next topic!

Honorable mention goes out to the following members for submitting ten Top Ten reasons: MPA, mclva123, kaiyokanman28 and lllosingit. Thanks, folks!

Think you're funny? Send us an entry (via the Submit button or the forum link below) for the **Top Ten Signs That You Have Too Many Tanks...**

If you have questions, would like to suggest a future Top Ten topic or place an entry, visit our online **forum** or hit the button below: